

TAB J

PART 6

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ference at the IC module substrate layer may be also formed.

IC module (3)

In this embodiment, the specific feature resides in 5 applying smoothening working on the backface of the IC module (the face on the side at which it is embedded in the card substrate).

That is, in this embodiment, after filling (and curing) 10 of the mold resin in the embodiment (1), the backface (the side of sealing frame layer) of the module is worked by smoothening (or mirror finishing) according to polishing or other methods. As the method for such smoothening working, it is possible to perform cutting working by means of a bite, milling, etc., or grinding by 15 means of grind stone, file or honing, lapping, discharging working, etc. Further, it is possible to employ the method in which the surface is smoothened by scraping off the resin before the sealing resin is completely cured.

FIG. 16 is a sectional view when smoothening working 20 is performed by means of a grinder. As shown in this figure, an IC module 4 filled with a resin for mold 39 is placed in a module fixing implement 41 and fixed under suction by vacuum evacuation. Then, by carrying out smoothening working by grinding the surface of the sealed resin by means of a rotary grind stone 42, the 25 preparation step of the IC module is completed.

Therefore, in this embodiment, since smoothening working is applied by a grinder, etc., on the sealed surface after resin sealing of the IC chip portion, it is not 30 necessary to perform cumbersome operations such as controlling the amount of the sealed resin at high precision during filling of the resin or controlling the fluidity of the resin as practiced in the prior art.

Further, the IC module obtained as described above 35 is worked to a smooth surface (mirror surface) on the side embedded in the card substrate, and therefore the module thickness precision can be improved, whereby generation of unevenness, sink mark, etc., on the outer surface of the card after molding of IC card particularly 40 at the peripheral portion of module, and destruction of IC chip can be prevented to improve yield of the IC card.

IC module (4)

When the IC module has a plurality of IC chips (for 45 example, one chip micom and memory chip) mounted thereon, it is preferred that the sealing frame layer 35 should have the independent windows of shapes for permitting the respective IC chips 36 to extend there-through, respectively, as shown in FIG. 14 and FIG. 15A. FIG. 17 is a plan view of the sealing frame layer 35 50 in this case. Also, FIG. 18 is a plan view of a sealing frame layer in an embodiment including three IC chips. Thus, since independent windows 40 corresponding to the respective IC chips are formed in the sealing frame layer 35 in the IC module of the present invention (namely, since the sealing frame layer exists between the respective windows), the following effects can be obtained.

(a) As compared with one having no sealing frame 55 between the IC chip embedding holes, mechanical strength and flexibility of IC module against external force such as bending, twisting, etc., can be improved, whereby IC chip and IC module can be excellently prevented from breaking.

(b) Since the amount of the resin for sealing used in the preparation step can be made smaller, and also the

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stress at the interface between the resin and IC chip created by temperature difference can be made smaller, warping of an IC module or any other deleterious influence on an IC chip can be reduced.

IC module (5)

The IC module shown in FIG. 8B is a modification of the IC module shown in FIG. 8A.

In this embodiment, a circuit pattern 33b is formed on only one side of a circuit pattern layer 33 (i.e., on the sealing frame layer 35 side). Accordingly, in this embodiment, it is not necessary to form through-holes 33c in the circuit pattern layer 33 as in the embodiment shown in FIG. 8A. A circuit pattern 33b (a dummy pattern which does not contact electrically with an external terminal) can be formed on a side of the circuit pattern layer 33 (on the IC module substrate 31 side) for imparting hardness to the IC module.

Other components and methods for producing this IC module are the same as the above embodiment (1).

IC module (6)

The IC module shown in FIG. 8C is a modification of the IC module shown in FIG. 8B.

In this embodiment, on one surface of an IC module substrate 31, e.g., a glass epoxy film with a thickness of about 0.3 mm, is formed an electrode pattern 32, and on the other surface of an IC module substrate 31, is formed a circuit pattern 33b. Next, a cavity for mounting an IC chip 36 is formed by boring at a depth of about 0.2 mm. Other, components and methods for producing IC module are the same as the above embodiment (1).

The present invention is described in more detail by referring to the following examples, but the present invention is not limited to these examples.

EXAMPLE A-1 (PREPARATION OF REINFORCING SHEET, TEST EXAMPLE)

A mesh sheet was coated and impregnated with an adhesive to prepare an adhesive sheet as shown in FIG. 5(a).

Such an adhesive sheet can be obtained by coating, for example, a polyester mesh "T-305S" (305 mesh/inch; NBC Kogyo Co.) with a nitrile rubber type adhesive by means of a dip coater at a proportion of 50 g/m² (dry state).

The thickness in this case was about 70 μ . The adhesive sheet thus obtained was found to be heat-sealable, and the adhesive sheet was sandwiched between two sheets of an unstretched rigid vinyl chloride resin sheet with a thickness of 0.2 mm, followed by hot pressing at 120° C. under 30 kg/cm² for 15 minutes to obtain a reinforced laminate of a rigid vinyl chloride sheet with a thickness of 0.45 mm.

A rigid vinyl chloride sheet with a thickness of 0.45 mm not containing the above adhesive sheet as comparative example and the reinforced rigid vinyl chloride sheet obtained in the above example were subjected to the test of folding endurance by means of an M.I.T. type folding endurance tester under the load of 1.5 kg with a test strip width of 15 mm. The test results are shown in Table A-1 below in terms of the number of folding before the test strip is cut.

TABLE A-1

Folding endurance	
Example A-1	More than 40,000 times

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TABLE A-1-continued

	Folding endurance
Comparative Example	1,800 times

As is apparent from the above results, the rigid vinyl chloride sheet laminate with the adhesive sheet of this example exhibited excellent folding endurance.

EXAMPLE B-1 (PREPARATION OF REINFORCING SHEET, TEST EXAMPLE)

As shown in a cross-sectional view in FIG. 19, a mesh 62 comprising Tetron "T-270T" (270 mesh/inch; NBC Kogyo Co.) was superposed on a substrate 61 comprising a transparent rigid vinyl chloride sheet with a thickness of 100 μ m, and further a stainless steel plate (luster plate) 63, a chip ball (cushioning material) 64, surface plates of a pressing machine 65 were further superposed thereon, to carry out hot pressing under a flat pressure (150° C., 20 minutes, 40 kg/cm²). As a result, a sheet for reinforcement having a mesh 62 in the surface layer of the substrate 61 as shown in FIG. 20 was obtained.

Together with a conventional rigid vinyl chloride sheet with a thickness of 100 μ containing no mesh as comparative example, folding endurance test was conducted by means of an M.I.T. type folding endurance tester under the load of 1.5 kg with a test strip width of 15 mm. The results are shown in Table B-1 below in terms of the number of folding before the test strip is cut.

TABLE B-1

	Folding endurance
Example B-1	More than 30,000 times
Comparative Example	About 1,500 times

Thus, the rigid vinyl chloride sheet containing mesh of this example exhibited very excellent folding

EXAMPLE B-2 (THE SAME AS ABOVE)

Using the reinforcement sheet prepared in the same manner as Example B-1, a plastic card with a thickness of 0.76 mm was prepared according to the method as described below. As shown in the cross-sectional view in FIG. 21, sheet for reinforcement 51 (oversheet) were superposed on both upper and lower sides of a center core (vinyl chloride sheet) 66 with a thickness of 0.56 mm applied with a desired printing with the mesh surface being inner side, and hot pressing was carried out under the same conditions as Example B-1 (150° C., 20 minutes, 40 kg/cm²), followed by punching out in a card size to prepare a plastic card with a thickness of 0.76 mm. It is also possible to form a magnetic recording layer (not shown) on the reinforcing sheet 51 (oversheet), if necessary.

As a comparative example, a plastic card with a thickness of 0.76 mm was prepared in the same manner by use of a rigid vinyl chloride sheet (oversheet) with a thickness of 100 and μ containing no mesh.

From these cards, samples embossed on all the lines at the positions determined by JIS and those without emboss were prepared, and, at a deflection amount of 14.5 mm height in the shorter side direction, bending test (30 times/minute) was practiced for 3,000 times for embossed samples and 5,000 times for samples without emboss. The results are shown in Table B-2 below.

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TABLE B-2

	Without emboss	Embossed
Example B-2	Without fracture of card	Without fracture of card
Comparative example	Fracture generated in card after about 1,500 times	Fracture generated in card after about 1,200 times

As is apparent from the above results, the plastic card prepared from a vinyl chloride oversheet containing mesh has bending strength by far superior to the card containing no mesh.

EXAMPLE B-3 (THE SAME AS ABOVE)

As shown in the cross-sectional view in FIG. 22, a mesh 62 comprising Tetron "T-150T" (150 mesh/inch; NBC Kogyo Co.) was superposed on a sheet substrate 61 comprising a transparent rigid vinyl chloride sheet with a thickness of 100 μ m, and further stainless steel plates 63a subjected to matte working by a sand matte were superposed thereon to carry out hot pressing in the same manner as Example B-1. As a result, a sheet for reinforcement 51 applied with matte working on both surfaces of the substrate 61 as shown in FIG. 23 was obtained. Matte working can be applied on any desired surface by replacing the above stainless steel plates 63a with the desired plate.

By use of the reinforcing sheet obtained, the same evaluation as Example B-1 and the evaluation of the card prepared in the same manner as Example B-2 were conducted. As the result, folding endurance was found to be 30,000 times or more and, in the card bending test, good performance was exhibited without fracture after 3,000 times for embossed sample and 5,000 times for sample without emboss. At the same time, air escape during press lamination was also good, whereby a card with excellent appearance and luster could be obtained without lick and sink on the card surface.

EXAMPLE B-4 (THE SAME AS ABOVE)

With a nylon mesh "N-270T" (270 mesh/inch; NBC Kogyo Co.) sandwiched between the two sheets of a vinyl chloride sheet with a thickness of 40 μ , a vinyl chloride sheet containing mesh subjected to matte working on both surfaces was prepared in the same manner as Example B-3.

These were subjected to evaluation according to the same methods as Examples B-1 and B-2. As the result, the same excellent performance as the evaluation result in Example B-3 was exhibited.

EXAMPLE B-5 (THE SAME AS ABOVE)

As shown in the cross-sectional view in FIG. 24, a polyester-isocyanate type adhesive 66 having terminal OH groups "AD-502" (produced by Toyo Morton Co.) was applied to an amount of 5 g/m² on one surface of a sheet substrate 61 comprising a vinyl chloride sheet with a thickness of 40 μ by use of a dry laminator, dry laminated on a mesh 62 (Tetron mesh "T-200S" (200 mesh/inch; NBC Kogyo Co.)), and the laminate was wound up with a releasing paper interposed. Further, on the mesh surface of this film, the same adhesive was applied to an amount of 5 g/m², and a vinyl chloride sheet with a thickness of 40 μ was dry laminated thereon to prepare a sheet for reinforcement with a structure having a mesh sandwiched between two sheets of vinyl chloride sheet with a thickness of 40 μ .

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When the same evaluations were conducted according to the methods as Examples B-1 and B-2 by use of the sheet for reinforcement obtained, excellent performance was exhibited similarly as the evaluation results in Example B-3.

EXAMPLE B-6 (THE SAME AS ABOVE)

A rigid vinyl chloride sheet with a thickness of 40 μ was coated on one surface by a roll coater with a urethane type adhesive to an amount of 4 g/m², and two sheets of the thus coated sheet were subjected to hot pressing in the same manner as Example B-3 with the adhesive coated surfaces facing innerward and with a Tetron mesh "T-150S" (150 mesh/inch; NBC Kogyo Co.) sandwiched therebetween to prepare a sheet for reinforcement which is matte on both surfaces or one surface.

When the same evaluations were conducted according to the methods as Examples B-1 and Example B-2, excellent reinforcing performance was exhibited similarly as the evaluation results in Example B-3.

EXAMPLE C-1 (LAYING OF MESH SHEET)

In this example, a mesh comprising a network-shaped sheet (for example, polyester mesh "T-270T" (270 mesh/inch; NBC Kogyo Co.) is formed by laying between the center core and the oversheet. As shown in FIG. 6(a), the mesh is laid over the whole card in this example. In this case, the card has a thickness of 0.76 mm.

Next, the method for preparation of the plastic card according to the above example is to be explained. First,

a mesh is sandwiched between a center core applied with a necessary printing and an oversheet, and the composite under this state is subjected to hot pressing (150° C., 25 kg/cm², 20 minutes) and then punched out in a card size to complete a plastic card. It is also possible to form a magnetic recording layer on the oversheet, if necessary. The mesh may be previously embedded on one surface of the oversheet by hot press, etc., or alternatively a laminate laminated with an adhesive, etc., may be used.

The mesh surface may be on the card surface side, or within the oversheet.

As comparative example, a plastic card with a thickness of 0.76 mm having the same laminated composition as this example except for containing no mesh was prepared. From these cards, samples having formed embossed letters on all the lines at the positions determined by JIS and samples having formed no such letter were prepared and, at a deflection amount of 14.5 mm height in the shorter side direction, bending tests (30 times/min.) were practiced 3,000 times for embossed samples and 5,000 times for non-embossed samples. The results are shown in Table C-1 below.

TABLE C-1

	Without emboss	Embossed
Example C-1	Without fracture of card	Without fracture of card
Comparative	Fracture generated in	Fracture generated in

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TABLE C-1-continued

	Without emboss	Embossed
example	card after about 1,500 times	card after about 1,200 times

These results show that the plastic card prepared with a vinyl chloride oversheet containing mesh has a bending strength by far superior to that of the card containing no mesh.

EXAMPLE C-2 (THE SAME AS ABOVE)

In this example, a mesh is formed by laying between center cores. The mesh material in this case may be a nylon 200 mesh/inch "N-270T" (NBC Kogyo Co.). As shown in FIG. 6(a), mesh as formed over the whole card in this example. In this embodiment, the card has a thickness of 0.76 mm.

The mesh may be embedded previously on one surface in the center core by a hot press, or alternatively a laminate laminated with an adhesive may be used. Also, as shown in FIG. 6(b), it may have a shape having no mesh layer at the edge portions so that the mesh may fringe the four corners of the card.

Samples of this card of application with emboss on all the lines at positions determined by JIS and without application of emboss were prepared, and the bending test (30 times/minute) was practiced at a deflection amount of 14.5 mm height at shorter side direction 3,000 times for embossed samples and 5,000 times for samples without emboss. The results are shown in Table C-2 shown below.

TABLE C-2

	Without emboss	Embossed
Example C-2	Without fracture of card	Without fracture of card
Comparative example (as described in Example C-1)	Fracture generated in card after about 1,500 times	Fracture generated in card after about 1,200 times

These results show that the plastic card prepared with a vinyl chloride oversheet containing mesh has a bending strength by far superior to that of the card containing no mesh.

EXAMPLE C-3 (THE SAME AS ABOVE)

In this example, a plastic card with the same laminate composition with which as Example C-1 was prepared. However, the direction in which the mesh was laid was made at an angle of $\alpha=45^\circ$ as shown in FIG. 7.

When this laminated structure is punched out into a card size, fraying of the fiber of mesh from the card edge can be prevented, and further with respect to fracture by the bending test, excellent performance was exhibited similarly as Example C-1.

EXAMPLE C-4 (THE SAME AS ABOVE)

The card in this example was made to have a shape of the mesh laid between the center core and the oversheet as shown in FIG. 6(b), by cutting the mesh so that the four corners of the card were just fringed by the mesh.

Next, the method for preparation of the plastic card according to the above example is explained. First, a mesh is sandwiched between a center core applied with necessary printing and coated on both surfaces with urethane type adhesive for lamination according to the method such as roll coating, gravure coating, etc., and an oversheet, and the composite under this state is sub-

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jected to hot pressing (110° C., 25 kg/cm², 20 minutes) and then punched out in a card size to complete a plastic card. It is also possible to form a magnetic recording layer on the oversheet, if necessary.

Samples of this card with application of emboss on all the lines at positions determined by JIS and without application of emboss were prepared, and the bending test (30 times/minute) was practiced at a deflection amount of 14.5 mm height at shorter side direction 3,000 times for embossed samples and 5,000 times for samples without emboss. The results are shown in Table C-3 shown below.

TABLE C-3

	Without emboss	Embossed
Example C-3	Without fracture of card	Without fracture of card
Comparative example (as described in Example C-1)	Fracture generated in card after about 1,500 times	Fracture generated in card after about 1,200 times

These results show that the plastic card prepared 20 with a vinyl chloride oversheet containing mesh has a bending strength by far superior to that of the card containing no mesh. Also, when punched out into a card size, fraying of the mesh fiber from the card edge can be prevented.

EXAMPLE D-1 (PREPARATION OF IC CARD)

FIGS. 25(a)~(f) are perspective views of the respective construction members of the IC card of the present invention.

First, according to a transfer method, an ethylene-acrylic acid copolymer hot adhesive "AC2000" (Mitsubishi Yuka Fine Co.) is formed on one surface of a white polyester film (Diafoil W-100, 25 μm thickness; Diafoil Co.), and further on the other surface, an ethylene-vinyl acetate copolymer hot adhesive (EC1200; Mitsubishi Yuka Fine Co.) was formed to a thickness each of 120 μm, to prepare an adhesive sheet (reinforcing sheet) 8.

Next, the adhesive sheet 8 was cut out so as to have 40 a greater area than the IC module 4 and adhered tentatively on a hot plate so that the adhesive layer AC2000 was oriented toward the IC module side. Subsequently, this was laminated together with center cores 1a and 1b, and the oversheet 2a provided with holes at the IC module embedding portions and the oversheet 2b, and integrated according to the hot press method to obtain an IC card.

The IC card thus obtained was found to be free from the problems such as peel-off of IC module during card bending or generation of cracks of the oversheet, because both good adhesiveness and reinforcing effect could be exhibited. Also, due to use of the white polyester, it was excellent in the shielding effect of IC module.

EXAMPLE B-6 (THE SAME AS ABOVE)

As shown in FIG. 26, first on both surfaces of a polyester film (Lumilar, 16 μm thickness; Toray Co.), a hot adhesive (EC1200; Mitsubishi Yuka Fine Co.) was formed according to roll coating to a thickness of 20 μm, to prepare an adhesive sheet 8a.

Next, an IC module was inserted into the center cores 1a, 1b, and the oversheet 2a provided with holes at the IC module corresponding portions, and, with arrangement of the adhesive sheet 8a having the same shape as the card on the backside, the oversheet 2b was further superposed thereon, followed by hot pressing to prepare an IC card.

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When the IC card thus obtained was subjected to bending test (according to ISO), there occurred no problem such as peel-off of IC module edge or crack of the oversheet.

EXAMPLE E-1 (PREPARATION OF IC CARD)

This embodiment is formed according construction as FIG. 25(a)~(f). First, after die bonding and wire bonding of an IC chip on a white multilayer substrate, resin sealing was carried out with a white mold resin (ME868; Amicon Co.)

Next, on both surfaces of a white polyester film (25

μm thickness), hot adhesive layer (EC1200; Mitsubishi Yuka Fine Co.) was formed to a thickness each of 20 μm to obtain a reinforcing sheet 8 which also functions as the shielding layer.

Subsequently, after the shielding layer (reinforcing) sheet 8 was tentatively plastered on the backside of the IC module 4, this was laminated together with center cores 1a and 1b, and oversheet 2a provided with holes at the IC module embedding portions and oversheet 2b, followed by integration according to the hot press method to obtain an IC card. In this case, as the oversheet 2b, an opaque white oversheet containing titanium white was employed.

When the IC card thus obtained was observed from the backside, no shade of the IC module portion was recognized.

EXAMPLE E-2 (THE SAME AS ABOVE)

FIG. 27(a)~(f) are perspective views of the respective construction members of the IC card of the present invention according to another embodiment.

The IC module 4 and the reinforcing sheet 8a prepared were the same as those in the foregoing Example E-1. Further, a shielding layer 8b comprising a white ink layer was formed on the oversheet 2b, following otherwise the same procedure as Example E-1 to prepare an IC card.

The IC card obtained was found to be excellent in shielding the IC module portion and aesthetic characteristic, and it has also been rendered possible to print on the backside portion of the IC module.

In the following Examples F-1 to F-13, the embodiments as shown in FIG. 15A and FIG. 4(a) were used as the IC module, but, all the IC modules disclosed in the specification are available for use in the following examples.

EXAMPLE F-1 (PREPARATION OF IC CARD)

As shown in the cross-sectional view in FIG. 28, the IC card according to this example has an IC module 4 arranged through an adhesive layer 6 in the card substrate 3 comprising a laminate of the center cores 1a, 1b, and the oversheets 2a, 2b. The symbol 7 is a terminal for electrical connection to external portion. And, in this example, a reinforcing sheet layer 8 comprising a mesh of a network-shaped sheet (e.g., polyester mesh "T270T"; NBC Kogyo Co.) is formed by laying between the center core 1b and the oversheet 2b.

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As shown in the plan view in FIG. 29, in this Example, a reinforcing sheet layer 8 having slightly greater area and shape than the IC module 4 is laid. The card thickness (including the module portion) in this case is 0.70 to 0.81 mm.

Next, the method for preparation of the IC card according to the above example is discussed.

First, holes for embedding the IC card are formed at the predetermined portions of the center cores 1a, 1b and the oversheet 2a. The center cores 1a and 1b are coated on both surfaces with an urethane type adhesive for lamination by roll coating method, gravure coating method, etc. Here, the hole provided at the center core 1b is formed corresponding to the shape of the reinforcing member.

Next, the oversheet 2a, the center cores 1a, 1b are superposed in this order, simultaneously with insertion of the IC module 4 having an adhesive layer 6 formed thereon into the hole for embedding the IC module, and the reinforcing sheet layer 8 and the oversheet 2b are superposed in this order. Under this state, hot pressing is performed (110° C., 25 kg/cm², 15 minutes), followed by punching out into a card size to complete an IC card. It is also possible to form a magnetic recording layer (not shown) on the oversheets 2a, 2b, if necessary.

For the IC card thus obtained, the bending test was conducted under the conditions shown below as determined by ISO by use of a bending tester produced by GAO.

Test conditions

(1) Bending in the longer side direction of card:

Bent for 250 times at the rate of 30 times/min. each in the face direction and the back direction with a deflection amount of 2 cm.

(2) Bending in the shorter side direction of card:

Bent for 250 times at the rate of 30 times/min. each in the face direction and the back direction with a deflection amount of 1 cm.

As a result, the card of this example was found to be free from breaking or crack at the boundary portion between the IC module and the card substrate, and also of the IC module, thus exhibiting excellent performance without change in appearance, and also the actuations of reading and writing functioned normally.

EXAMPLE F-2 (THE SAME AS ABOVE)

In this example, as shown in the cross-sectional view in FIG. 30, a reinforcing sheet layer 8 is formed by laying on the whole surface of an oversheet 2b. As the mesh material in this case, for example, Tetron mesh "T-120S" (120 mesh/inch; NBC Kogyo Co.) can be used. The card thickness in this case (including the module portion) is 0.78 to 0.80 mm.

The IC card thus obtained was found to be free from curl. Also, when evaluated according to the same method as Example F-1, there was no breaking or crack at the boundary portion between the IC module and the card substrate, and also without flying-out of the module. Thus, excellent performance was exhibited without change in appearance, and actuations of reading and writing also functioned normally.

EXAMPLE F-3 (THE SAME AS ABOVE)

In this example, as shown in the cross-sectional view in FIG. 31 and the plan view in FIG. 32, a reinforcing sheet layer 8 is formed in shape of a sword guard so as to cover only the peripheral portion of the boundary

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between the IC module 4 and the center core 1b. As the mesh material in this case, nylon mesh "N-270T" (270 mesh/inch; NBC Kogyo Co.) can be used. The card thickness in this case (including the module portion) is 0.70 to 0.81 mm.

As the result of evaluation according to the same method as Example F-1, excellent performance was exhibited without breaking or crack at the boundary portion between the IC module and the card substrate, without flying-out of the module or change in appearance. Actuations of reading and writing also functioned normally.

EXAMPLES F-4 TO F-7 (THE SAME AS ABOVE)

The IC card shown in FIG. 33 is an example in which a reinforcing sheet layer 8 is embedded in the oversheet 2b. Even in such an embodiment, sufficiently excellent reinforcing effect can be obtained.

The IC card shown in FIG. 34 is an example in which a reinforcing sheet layer 8 is formed at the bottom of the oversheet 2b. In the case of producing an IC module of this embodiment, in the embodiment as shown in FIG. 28 as described above, the oversheet 2b and the reinforcing sheet layer 8 may be laminated in reverse order.

The IC card shown in FIG. 35 is a card of the type in which the oversheet 2a extends on the surface of the IC module 4 and only the terminal 7 for connection is exposed. In the case of such an IC card, it is also possible to form a reinforcing sheet layer 8 on the side of the oversheet 2a. In this case, the boundary portion between the IC module 4 and the center core 1a on the terminal 7 side is reinforced.

Although the portion of the external terminal 7 may be constructed as shown in FIG. 35 or FIG. 36 so that the external terminal 7 may be positioned in the recessed portion relative to the oversheet 2a, the advantage of (a) prevention of accumulation of dust at the external terminal portion and also (b) better running performance of the card when the IC card is subjected to reading/writing device can be obtained by forming the external terminal on the same plane as the oversheet 2a as shown in FIG. 33.

Also as shown in FIG. 36, it is possible to provide reinforcing sheet layers on both surfaces of the IC module.

Further, in FIG. 35 and FIG. 36, the reinforcing sheet layer 8 may be embedded internally of the oversheet as shown in FIG. 33 or FIG. 34, or alternatively at the surface portion of the oversheet.

EXAMPLE F-8 (THE SAME AS ABOVE)

The reinforcing sheet layer was formed in a porous metal sheet as shown below, and an IC card was prepared in the same manner as Example F-1.

Metal sheet: 30μ thick stainless steel film,

Hole pitch: 250μ,

Hole size: 250μ (diameter), prepared by etching method.

The IC card thus obtained was found to have a card thickness (including the module portion) of 0.78 to 0.80 mm.

EXAMPLE F-9 (THE SAME AS ABOVE)

In this example, as shown in the cross-sectional view in FIG. 37, a reinforcing material comprising a mesh sheet 8a impregnated by coating with an adhesive layer 10 was used as the reinforcing sheet layer 8.

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Such a reinforcing sheet layer can be obtained by coating, for example, polyester mesh "T-305S" (305 mesh/inch; NBC Kogyo Co.) with a nitrile rubber type adhesive by a dip coater at a proportion of 40 g/m² (dry state). The thickness in this case is about 60 μ m. Otherwise, an IC card can be produced according to the same method as Example F-1.

Also, the above reinforcing sheet layer 8 is formed to have slightly greater area and shape than the module portion, as shown in this example.

Thus, since the reinforcing sheet layer 8 in this Example has also the function of an adhesive layer, the step for forming separately an adhesive layer at the bottom of the module can be advantageously omitted.

When the IC card thus obtained was evaluated according to the same method as Example F-1, there was no breaking or crack at the boundary portion between the IC module and the card substrate without flying-out of module or change in appearance. Thus, excellent performance was exhibited with normal functioning of reading and writing.

EXAMPLE F-10 (THE SAME AS ABOVE)

The reinforcing sheet layer 8 in this example is constituted of adhesive layers 10 on both surfaces of an unwoven fabric 8a as shown in FIG. 38.

As such a reinforcing sheet layer, for example, an unwoven fabric sheet substrate coated on both surfaces with a synthetic rubber type adhesive such as an adhesive sheet "M-5251" (90 μ m thickness; produced by Nitto Denko Co.) can be used.

The IC card as shown in FIG. 38 can be prepared according to the method as described below.

First, at the predetermined portions of the center cores 1a, 1b, 1c applied with a desired printing and coated on both surfaces with an urethane type adhesive for lamination and the oversheet 2a, holes for embedding IC module are formed. Here, the hole provided at the center core 1b is formed so as to conform to the shape of the reinforcing member, and the hole provided at the center core 1c is formed so as to conform to the shape of the reinforcing sheet layer 8.

Next, the above oversheet 2a, center cores 1a, 1b, 1c are superposed in this order, and also the IC module 4 and the reinforcing sheet layer 8 are successively embedded in the holes, and hot pressing is performed under this state with the oversheet 2b being superposed thereon. Further, the composite is punched out into a card size to complete an IC card. It is also possible to form magnetic recording layers (not shown) on the oversheets 2a, 2b.

The reinforcing sheet layer in this example itself has also the function of an adhesive layer, and therefore the step of forming separately an adhesive layer at the bottom of the IC module can be advantageously omitted.

As the result of evaluation of the IC card thus obtained according to the method as Example F-1, there was no breaking or crack at the boundary portion between the IC module and the card substrate, no separation or falling off of the module and change in appearance of the card, thus exhibiting excellent performance with normal functioning of actuations such as reading and writing.

EXAMPLE F-11 (THE SAME AS ABOVE)

In this example, as shown in FIG. 39, the reinforcing sheet layer 8 is constituted of a rubbery adhesive sheet layer. Such an adhesive layer can be formed of, for

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example, a nitrile rubber type adhesive (e.g., "T-5300" (50 μ m thickness; Nitto Denko Co.)). In this case, the reinforcing sheet layer has a thickness of about 0.05 mm, with the card thickness (including the module portion) being 0.78 to 0.82 mm.

The reinforcing sheet layer in this example itself has also the function of an adhesive layer, and therefore the step of forming separately an adhesive layer at the bottom of the IC module can be advantageously omitted.

Such an IC card can be prepared in the same manner as Example F-1.

It is also possible to form magnetic recording layers (not shown) on the oversheet 2a, 2b, if necessary.

EXAMPLE F-12 (THE SAME AS ABOVE)

In this example, as shown in FIG. 40, the reinforcing sheet layer 8 is composed of an adhesive sheet comprising adhesive layers 10 on both surfaces of a plastic film base 11. Such an adhesive sheet may be, for example, one having a nitrile rubber type adhesive coated on both surfaces of a PET film base with a 12 μ m thickness, e.g., "T-5330" (60 μ m thickness; Nitto Denko Co.).

The reinforcing sheet layer in this example itself has also the function of an adhesive layer, and therefore the step of forming separately an adhesive layer at the bottom of the IC module can be advantageously omitted.

The IC card according to this example can be produced according to the same method as the above example F-1. The card thickness in this case including the module portion is 0.78 to 0.80 mm.

Also, the above reinforcing sheet layer 8 may be any of the embodiments shown in FIGS. 28~29, FIGS. 31~32 as described above, other than the embodiment laying over the whole card surface as in this example.

As the result of evaluation of the IC card thus obtained according to the method as Example F-1, there was no breaking or crack at the boundary portion between the IC module and the card substrate, no separation or falling off of the module and change in appearance of the card, thus exhibiting excellent performance with normal functioning of actuations such as reading and writing.

EXAMPLE F-13 (THE SAME AS ABOVE)

In this example, as shown in FIG. 41, the reinforcing sheet layer 8 is formed of an adhesive sheet having an adhesive layer 10 formed on one surface of a plastic film base 11. As such an adhesive sheet, for example, a PET film base with a thickness of 12 μ m having a nitrile rubber type adhesive coated on one surface to a thickness of 30 μ can be used.

Such an IC module can be prepared in the same manner as Example F-1. The card thickness in this case including the module portion is 0.78 to 0.82 mm.

Also, the above reinforcing sheet layer 8 may be any of the embodiments shown in FIGS. 28~29, FIGS. 31~32 as described above, other than the embodiment laying over the whole card surface as in this example.

As the result of evaluation of the IC card thus obtained according to the method as Example F-1, there was no breaking or crack at the boundary portion between the IC module and the card substrate, no separation or falling off of the module and change in appearance in the card, thus exhibiting excellent performance with normal functioning of actuations such as reading and writing.

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EXAMPLE G-1 (PREPARED OF IC CARD)

The following examples G-1 to G-3 are examples in which specific images are formed on the surface of IC card according to the transfer method.

The example shown in FIG. 42 is an example when a transfer layer 70 is formed on the backside surface of an IC card obtained according to the same method as the above examples F-1 to F-13. The transfer layer 70 can be formed by transfer at the same time when the IC card is integrated by hot press. The transfer sheet to be used at this time may consist of an OP layer (protective layer) 72 which also functions as a peeling layer, a printing layer 73, an anchor layer 74 and a colorant layer 75 which also functions as a heat seal layer laminated in this order on a transfer sheet substrate (e.g., PET film, 38 μm) 71.

In the case of the above example, by incorporating a desired metallic powder (Al, brass, etc.) the aesthetic characteristic in appearance of the IC card can be improved simultaneously with effective shielding of the IC module portion.

Also, practice of image formation on the IC card surface according to the transfer method a described above is advantageous in that distortions of picture patterns or letters liable to be generated in the vicinity of the IC module portion can be prevented.

Generally speaking, when a card is formed by embedding an IC module in the hole arranged in a card material comprising a vinyl chloride sheet, etc., followed by hot pressing, a phenomenon will inevitably occur that the substrate flows into a slight gap (around 0.1 mm) between the module and the arranged hole when the temperature of the substrate during heat pressing becomes its softening point (e.g., 50° ~ 60° C.) or higher. In this case, when a picture pattern is printed on the surface of the substrate, this flows together with the softened substrate, whereby distortion occurs on the picture pattern. Whereas, according to the transfer system as described above, the printed layer to be transferred is retained on the transfer sheet substrate having high heat resistance, and therefore no distortion will occur on the printed layer even if the IC card substrate may be softened during heat pressing. Further, with this method, productivity as well as quality can be advantageously improved.

In this case, it is also possible to provide a printed layer (not shown) between the oversheet 2a and the core sheet 1a.

EXAMPLE G-2 (THE SAME AS ABOVE)

The example shown in FIG. 44 is an embodiment when a printed layer is formed also on the face side (terminal 7 side) of the IC card.

In this case, the colorant layer 75 is made white (containing titanium white), and the heat seal layer 75a is transparent. Other constitutions, and the preparation method are the same as in Example G-1.

In the case of this example, since a printed layer is provided according to the transfer method on the surface on the face side of the IC card, productivity as well as quality can be advantageously improved. Further, a printed layer can be easily formed on the surface of the IC module (except for the contact portion). In the prior art, when a printed layer is provided on the face side, it has been provided between the oversheet 2a and the center core 1a. However, according to this method, there is the problem that peel-off is liable to occur be-

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tween the oversheet and the center core (due to bad adhesion of ink with substrate). On the other hand, when printing is applied on the surface of the oversheet 2a, there is the problem with respect to productivity. In this example, by provision of a printed layer according to the transfer method by use of a transfer (L> sheet having the above construction, such problems can be cancelled.

Also, if necessary, it is possible to form a magnetic recording layer 9.

In the above example G-1 and this example, the OP layer 72 and the anchor layer 74 may be optionally formed, or they can be omitted. Also, the heat seal layer (colorant layer) 75 may be colored in a desired color (white, gold, silver, transparent, etc.). It may also be a laminate of a transparent heat seal layer and a colorant layer.

EXAMPLE H-1 (PREPARATION OF IC CARD)

As shown in the cross-sectional view in FIG. 1B, the IC card according to this example has an IC module 4 arranged through an adhesive layer 6 in the card substrate 3 comprising a laminate of the center cores 1a, 1b and the oversheets 2a, 2b. The symbol 7 is a terminal for electrical connection to external device. And, in this example, a reinforcing sheet layer 8 comprising a mesh of a network-shaped sheet (e.g., polyester mesh "T-270T" (270 mesh/inch; NBC Kogyo Co.) is formed by laying between the center core 1 and the oversheet 2b.

As shown in FIG. 1B, in this Example, the IC module 4 has no reinforcing member, but a reinforcing sheet layer 8 having slightly greater area and shape than the IC module 4 is laid. The card thickness (including the module portion) in this case is 0.79 to 0.81 mm.

Next, the method for preparation of the IC card according to the above example is to be explained.

First, holes for embedding the IC card are formed at the predetermined portions of the center cores 1 and the oversheet 2a. The center core 1 is coated on both surfaces with an urethane type adhesive for lamination by roll coating method, gravure coating method, etc. Here, the hole provided at the center core 1 and the oversheet 2a is formed corresponding to the shape of the IC module.

Next, the oversheet 2a, the center cores 1 are superposed in this order, simultaneously with insertion of the IC module 4 having an adhesive layer 6 formed thereon into the hole for embedding the IC module, and the reinforcing sheet layer 8 and the oversheet 2b are superposed in this order. Under this state, hot pressing is performed (110° C., 25 kg/cm², 15 minutes), followed by punching out into a card size to complete an IC card. It is also possible to form a magnetic recording layer (not shown) on the oversheets 2a, 2b, if necessary.

For the IC card thus obtained, the bending test was conducted under the conditions shown below as determined by ISO by use of a bending tester produced by GAO.

TEST CONDITIONS

(1) Bending in the longer side direction of card:

Bent for 250 times at the rate of 30 times/min. each in the face direction and the back direction with a deflection amount of 2 cm,

(2) Bending in the shorter side direction of card:

Bent for 250 times at the rate of 30 times/min. each in the face direction and the back direction with a deflection amount of 1 cm.

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As a result, the card of this example was found to be free from breaking or crack at the boundary portion between the IC module and the card substrate, and also without drop-off of the IC module, thus exhibiting excellent performance without change in appearance, and also the actuations of reading and writing functioned normally.

EXAMPLE H-2 (PREPARATION OF IC CARD)

As shown in the cross-sectional view in FIG. 1C, the IC card according to this example has an IC module 4 arranged through an adhesive layer 6 in the card substrate 3 comprising a laminate of the center cores 1a, 1b and the oversheets 2a, 2b. The symbol 7 is a terminal for electrical connection to external device. In this example, as shown in FIG. 1C, the IC module 4 has a reinforcing member 5.

Next, the method for preparation of the IC card according to the above example is to be explained.

First, holes for embedding the IC card are formed at the predetermined portions of the center cores 1a, 1b and the oversheet 2a. The center cores 1a and 1b are coated on both surfaces with an urethane type adhesive for lamination by roll coating method, gravure coating method, etc. Here, the hole provided at the center core 1b is formed corresponding to the shape of the reinforcing member 5.

Next, the oversheet 2a, the center cores 1a, 1b are superposed in this order, simultaneously with insertion of the IC module 4 having an adhesive layer 6 formed thereon into the hole for embedding the IC module, and the oversheet 2b are superposed in this order. Under this state, hot pressing is performed (110° C., 25 kg/cm², 15 minutes), followed by punching out into a card size to complete an IC card. It is also possible to form a magnetic recording layer (not shown) on the oversheets 2a, 2b if necessary.

Thus obtained IC card of this example was found to be free from breaking or crack at the boundary portion between the IC module and the card substrate, and also without drop-off of the IC module, thus exhibiting excellent performance without change in appearance, and also the actuations of reading and writing functioned normally.

What is claimed is:

1. An IC card comprising an IC module embedded in an IC module substrate built in a card substrate, said IC module comprising an IC chip, a circuit substrate and a reinforcing member, said reinforcing member comprising at least a part of the side portion of said IC module substrate extended in the outer circumferential direction, wherein said reinforcing member is formed in a shape so that it has a greater area toward the portion of the IC card with a greater flex coefficient.

2. An IC card according to claim 1, wherein a reinforcing sheet layer is laid in the planar direction of the card so as to cover at least the peripheral portion of the boundary between the card substrate and the IC module.

3. An IC card according to claim 1, wherein the sealing frame layer and/or the resin for mold constituting the IC module have/has a color identical or similar to that of a card substrate.

4. An IC card according to claim 1, wherein the IC module is applied with smoothening working on the backside thereof.

5. An IC card according to claim 1, wherein said IC module is an IC module having an IC chip mounted in

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a laminate of a plurality of substrates for formation of the IC module, at least one layer of said substrates for formation of the IC module has a reinforcing member extended in the outer circumferential direction of the IC module, and said reinforcing member is provided as extended so as to form a difference in level from the intermediate portion of said substrate for formation of the IC module.

6. An IC card according to claim 1, wherein said IC module comprises two or more IC chips mounted thereon, and the sealing frame layer forming the IC module has windows with shapes for permitting said respective IC chips to extend therethrough independently of each other.

7. An IC card according to claim 1, wherein an external terminal of the IC module is formed on the same plane as the surface of the card substrate.

8. An IC card according to claim 2, wherein the reinforcing sheet layer is formed of at least one material selected from the group consisting of mesh-like sheet, unwoven fabric, continuous body sheet, rubber sheet, thermoplastic elastomer sheet, rubbery adhesive layer and tacky sheet.

9. An IC card according to claim 2, wherein the reinforcing sheet layer comprises an adhesive sheet having a polyolefinic adhesive layer formed on both surfaces of a plastic film.

10. An IC card according to claim 2, wherein the reinforcing sheet layer has a color identical or similar to that of the card substrate.

11. An IC card according to claim 2, wherein the reinforcing sheet layer comprises an opaque white material.

12. An IC card according to claim 1, wherein the oversheet constituting the IC card is opaque white.

13. An IC card according to claim 1, wherein the card substrate is constituted with the oversheet having microindentations formed on one surface or both surfaces thereof.

14. An IC card according to claim 1, wherein the card substrate is constituted with the oversheet in which a mesh sheet is laid therein.

15. An IC card comprising an IC module embedded in a card substrate,

said IC card having a mesh sheet as a reinforcing sheet layer laid in the planar direction of the card so as to cover at least the peripheral portion of the boundary between the card substrate and the IC module;

said IC module having an IC chip mounted in a laminate of a plurality of substrates for formation of the IC module, at least one layer of said substrates for formation of the IC module having a reinforcing member extended in the outer circumferential direction of the IC module; and

said reinforcing member being formed in a shape so that it has a greater area toward the portion of the IC card with greater flex coefficient.

16. An IC module to be mounted in an IC card and embedded in an IC module substrate, said IC module comprising an IC chip, a circuit substrate and a reinforcing member, said reinforcing member comprising at least a part of the side portion of said IC module substrate extended in the outer circumferential direction, wherein said reinforcing member is formed in a shape so that it has a greater area toward the portion of the IC card with greater flex coefficient.

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17. An IC module according to claim 16, wherein the IC module is applied with smoothening working on the backside thereof.

18. An IC module according to claim 16, wherein said IC module is an IC module having an IC chip mounted in a laminate of a plurality of substrates for formation of the IC module, at least one layer of said substrates for formation of the IC module has a reinforcing member extended in the outer circumferential direction of the IC module, and said reinforcing member is provided as extended so as to form a difference in level from the intermediate portion of said substrate for formation of the IC module.

19. An IC module according to claim 16 wherein said IC module comprises two or more IC chips mounted

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thereon, and the sealing frame layer forming the IC module has windows with shapes for permitting said respective IC chips to extend therethrough independently of each other.

20. An IC module according to claim 16, wherein said IC module has a color identical or similar to that of a card substrate in which said IC module is built.

21. An IC card according to claim 15, wherein said reinforcing member is provided as extended so as to form a difference in level from the intermediate portion of said substrate for formation of the IC module.

22. An IC card according to claim 21, wherein said IC module is applied with smoothening working on the backside thereof.

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United States Patent [19]

Ohuchi et al.

[11] **Patent Number:** **4,931,853**
 [45] **Date of Patent:** **Jun. 5, 1990**

[54] **IC CARD AND METHOD OF MANUFACTURING THE SAME**

[75] **Inventors:** Masayuki Ohuchi, Tokyo; Hiroshi Oodaira, Chigasaki; Kenichi Yoshida, Tokyo, all of Japan

[73] **Assignee:** Kabushiki Kaisha Toshiba, Kawasaki, Japan

[21] **Appl. No.:** 403,772

[22] **Filed:** Sep. 6, 1989

Related U.S. Application Data

[63] Continuation of Ser. No. 32,450, Mar. 31, 1987, abandoned.

[30] **Foreign Application Priority Data**

May 20, 1986 [JP] Japan 61-115585

[51] **Int. Cl.⁵** H01L 23/02

[52] **U.S. Cl.** 357/74; 357/68; 357/80

[58] **Field of Search** 357/80, 74, 67, 68

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Primary Examiner—Andrew J. James

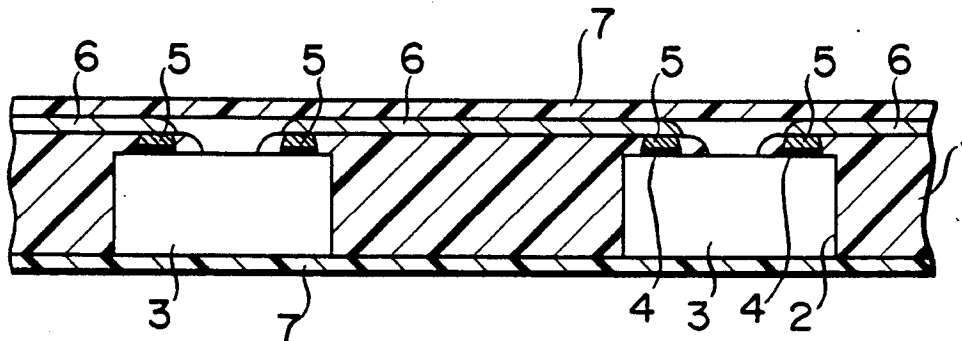
Assistant Examiner—Mark Prenty

Attorney, Agent, or Firm—Oblon, Spivak, McClelland, Maier & Neustadt

[57] **ABSTRACT**

An IC card comprises a thermoplastic resin core sheet and an IC chip bearing a conductive projection formed on an electrode of the IC chip, the IC chip being embedded in the core sheet in such a manner that the exposed top surface of the conductive projection is made flush with the main surface of the core sheet. A conductive layer pattern formed on the main surface of the core sheet is extended for contact with the exposed top surface.

9 Claims, 1 Drawing Sheet



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FIG. 1

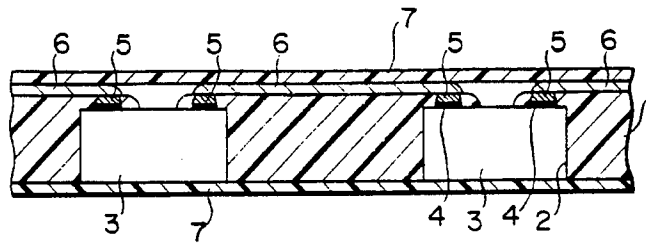


FIG. 2A

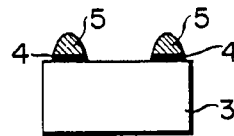


FIG. 2B

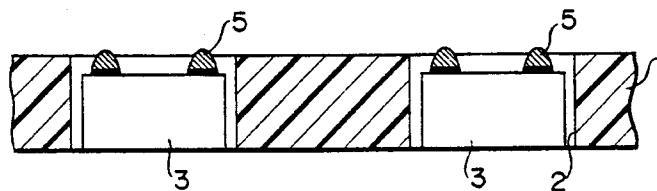


FIG. 2C

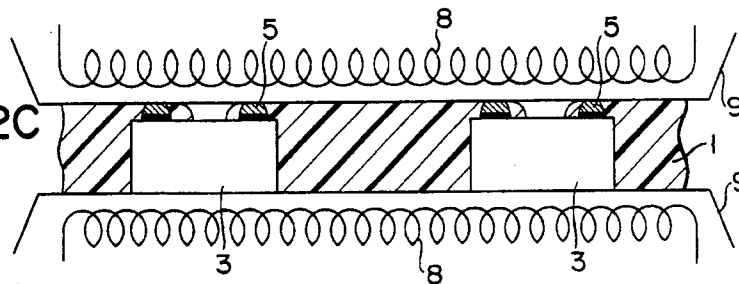


FIG. 2D

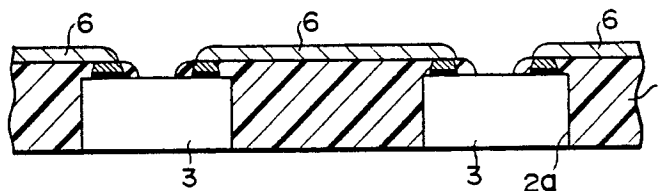
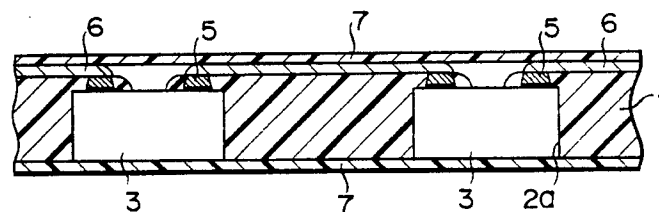


FIG. 2E



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IC CARD AND METHOD OF MANUFACTURING THE SAME

This application is a continuation of application Ser. No. 07/032,450 filed on March 31, 1987, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to an IC card and the method of manufacturing the same.

In the Japanese Patent application 59-196,206 the present inventors proposed a method of manufacturing an IC card which comprises the steps of embedding a semiconductor IC chip in an insulating core sheet, forming a conductive layer pattern on the main surface of the core sheet, and electrically connecting an electrode deposited on the IC chip to the conductive layer pattern. The proposed IC card-manufacturing method offered the advantage that since the exposed electrode of an IC chip embedded in a core sheet could be directly connected to the conductive layer pattern formed on the main surface of the core sheet, it became possible to provide a thin IC card. In contrast, the conventional IC card-manufacturing method had the drawback in that when the electrode deposited on the IC chip and the conductive layer pattern were connected together by a bonding wire, the so-called loop height (a portion inevitably raised in height due to the bonding wire connection) caused the thickness of the IC card to be increased.

In addition, the previously proposed IC card was further accompanied by the following drawback. Since the surface of the IC chip on which an electrode is formed is made flush with the main surface of the core sheet, part of the conductive layer pattern connected to the electrode contacts part of the surface of the IC chip. The surface of the IC chip is coated with a passivation layer prepared from phosphor silicate glass. Unless, therefore, the passivation layer partly falls off, the above-mentioned contact presents no difficulties. If, however, the passivation layer falls off at the above-mentioned portion, this can cause an electric short circuit between the conductive layer pattern and the IC chip.

Summary of the Invention

This invention has been accomplished in view of the above-mentioned circumstances and is intended to provide an IC card wherein a conductive layer pattern formed on a core sheet is extended through part of the surface of a semiconductor IC chip embedded in the core sheet, and the conductive layer pattern can be connected to the electrode formed on the IC chip without causing an electric short-circuit between the IC chip and the extended end portion of the conductive layer pattern.

An IC card according to this invention comprises an insulating core sheet, a semiconductor IC chip provided with an electrode and embedded in the core sheet, and a conductive layer pattern deposited on the core sheet for being connected to the electrode, wherein the semiconductor IC chip is provided with a conductive projection formed on the electrode and is embedded in the core sheet in such a manner that the exposed top surface of the conductive projection is made flush with the main surface of the core sheet on which the conductive layer pattern is deposited, and the conductive layer

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pattern is connected with the conductive projection at the exposed top surface.

A method for manufacturing an IC card involving a thermoplastic resin core sheet and a semiconductor IC chip embedded in the core sheet according to this invention comprises the steps of: preparing the thermoplastic resin core sheet with a greater thickness than that of the semiconductor IC chip and forming at least one hole penetrating the core sheet; forming a conductive projection on an electrode deposited on the semiconductor IC chip; inserting the semiconductor IC chip into the penetrating hole with the conductive projection positioned at the side of the main surface of the core sheet; plastically deforming the core sheet involving the inserted semiconductor IC chip by applying heat and pressure between the main and opposite surfaces until the exposed top surface of the conductive projection is made flush with the main surface of the core sheet; and depositing a conductive layer pattern on the main surface so as to be contacted with the exposed top surface.

Brief Description of the Drawings

FIG. 1 is a sectional view showing the main parts of an IC card embodying the present invention; and

FIGS. 2A to 2E are sectional views indicating the sequential steps of manufacturing the IC card representing the present invention.

Detailed Description of the Preferred Embodiments

Referring to FIG. 1, core sheet 1 of thermoplastic resin is formed of polycarbonate resin (manufactured by Teijin under the trademark "panlite") having a thickness of, for example, 0.32 mm. In the example of FIG. 1 core sheet 1 has two openings 2. Semiconductor IC chip 3, thinner than core sheet 1 (having a thickness of, for example, 0.29 mm), is embedded in each opening 2, as illustrated in FIG. 1. IC chip 3 comprises a plurality of input or output electrodes 4. Conductive projection 5 is formed on each electrode 4. Conductive projection 5 is made flush with the main surface of core sheet 1. A conductive layer pattern 6 is formed on the main surface of core sheet 1. Conductive layer pattern 6 extends through part of the surface of IC chip 3, and is electrically connected with the top surface of conductive projection 5. The side surface of the conductive projection 5 is surrounded by the same material as that of core sheet 1. The upper surface of core sheet 1, including conductive pattern 6, and the lower surface of core sheet 1 are coated with insulating cover sheet 7. Cover sheet 7 is provided with a plurality of holes (not shown). Data is taken into or out of IC chip 3 through the holes and the conductive layer pattern 6.

According to the arrangement of FIG. 1, the electrode 4 deposited on IC chip 3 and the conductive layer pattern 6 are connected together without the aid of a bonding wire, thereby enabling the IC card to be fabricated with a small thickness. Further, a thermoplastic insulating resin sheet prepared from the same material, for example, as core sheet 1, is interposed between the end portions of the conductive layer pattern 6 and the surface of IC chip 3. Even if, therefore, a passivation layer falls off part of the surface of IC chip 3, electric short circuiting does not arise between IC chip 3 and conductive layer pattern 6 through the fallen portion of the passivation layer.

Description may now be made with reference to FIGS. 2A to 2E of the steps of manufacturing an IC

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card according to the method of the present invention. First, a thermoplastic core sheet (not shown) is provided which has at least one penetrating hole 2 and is made thicker than an IC chip. Then, as shown in FIG. 2A, conductive projections 5 are mounted on electrodes 4 of IC chip 3. Conductive projection 5 should be made of such material as has a lesser hardness than silicon constituting IC chip 3 in order to prevent IC chip 3 from being broken when conductive projection 5 undergoes pressure.

It is preferred that conductive projection 5 be prepared from a transition metal selected from the group consisting of Au, Cu, Ag, Al, Zn, Pd, Sn, Os, Pt and Ir or an low-temperature melting alloy composed of at least two metals selected from the group consisting of Pd, Sn, In, Ag, Ga, Au, Bi, Te, Ge and Sb.

Description may now be made of forming conductive projection 5. When conductive projection 5 is formed of a transition metal, it is preferred to select any of the following processes: ball bonding, electroplating, vacuum deposition, sputtering, ion plating, laser growing and transcribing processes. When a low-temperature melting alloy is chosen, it is preferred to apply ultrasonic waves to the fusion of a low-temperature melting alloy and dip an IC chip in the fusion. Further, conductive projection 5 may also be prepared from a mass composed of metal and resin. In this case, it is advised to mix epoxy resin with silver powder, knead them into a paste and deposit the mass on the electrode of IC chip 3.

The height of conductive projection 5, namely, a height from the surface of IC chip 3 to the surface of conductive projection 5 is preferred to be a measurement arrived at by subtracting the thickness of IC chip 3 (in this example, 0.29 mm) from the thickness of core sheet 1 (in this example, 0.32 mm), namely, larger than 30 microns. In the aforementioned example, ball bonding involving Au was applied to the surface of the electrode of IC chip 3. Later, the bonding wire portion was cut off, thereby retaining Au balls alone on the electrode as conductive projections. In this case the height of the Au ball, namely, conductive projection 5, measured 50 microns.

Then, as shown in FIG. 2B, IC chip 3 provided with conductive projections 5 is inserted into penetrating hole 2 having a larger opening than the outer measurement of IC chip 3. In this case, care is taken to insert IC chip 3 in such a manner that conductive projections 5 are set on the main surface of core sheet 1. Core sheet 1 may be prepared not only from the aforementioned polycarbonate resin, but also from any of the following resins: polyvinyl chloride, polyvinyl chloride-acetate copolymer, polysulfone, polyethylene terephthalate, polyetherketone, polymethyl-pentene, polyallylate, polyether-sulfone, polyether-imide, polyphenylene-sulfide and ABS. When IC chip 3 is inserted into penetrating hole 2, the rear surface of IC chip 3 is made flush with the rear surface of core sheet 1. At this time the top of conductive projection 5 projects 0.02 mm from the front surface (main surface) of core sheet 1.

In the next step, as shown in FIG. 2C, core sheet 1 is sandwiched between two heating and pressurizing members each containing heating coil 8 to be heated and pressurized. Now let it be supposed that polycarbonate core sheet 1 is heated to 200° C., and a pressure of 20 kgf/cm² is applied between the top and bottom surfaces of core sheet 1. Then core sheet 1 undergoes plastic deformation, and a space between the side surfaces of IC chip 3 and the inner surfaces of penetrating

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hole 2 is filled with polycarbonate resin. As a result, the top surface of conductive projection 5 is made flush with the main surface of core sheet 1. At this time, the side surface of conductive projection 5 is covered with the material of core sheet 1, and the top surface of conductive projection 5 is exposed. The foregoing step may be replaced by the process of pressurizing conductive projections 5 in advance to reduce its height to a level reached by subtracting the thickness of semiconductor chip 3 from that of core sheet and thereafter pressurizing core sheet 1.

Later, as shown in FIG. 2D, a conductive layer pattern 6 is formed on the main surface of core sheet 1 in such a manner that an end portion of the conductive layer pattern contacts the exposed top surface of conductive projection 5. Conductive layer pattern 6 can be prepared by the process of mixing resin with powder of a single metal selected from the group consisting of Au, Ag, Cu, Pt, Ni, Sn, W, Mo, Pd, SiC, C and RuO₂, or powder of an alloy composed of at least two metals selected from the group, or powder of metal oxide to provide a conductive paste, and printing the paste.

The content of the metal powder mixed with the resin varies with the kind of the metal. In the case of the powder of Ag, at least 70% by weight will provide paste of high conductivity. In the example of the present invention, conductive layer pattern 6 is formed by mixing 90% by weight of Ag powder with polycarbonate resin and screen printing the resultant Ag paste. When powder of any other metal is applied, it will serve the purpose if the resin is mixed with a sufficient amount of metal powder to render the resultant paste effectively conductive.

A conductive layer pattern 6 can also be prepared by the process of depositing a layer of any metal selected from the group consisting of Au, Ag, Cu, Pt, Ni, Sn, W, Mo, and Pd on the surface of core sheet 1 by the process of vacuum deposition, sputtering or electroless plating and fabricating a prescribed pattern of conductive layer by photolithography.

Later, as indicated in FIG. 2E, cover sheet 7, prepared from the same material as that of core sheet 1, is deposited on both top and bottom surfaces of core sheet 1. Cover sheet 7 is fused with the core sheet 1 and conductive layer pattern 6 by applying heat and pressure. Later, the fused mass is punched in the prescribed pattern to provide a required IC card.

The above-mentioned IC card manufacturing method embodying the present invention offers the advantages that the IC card can be fabricated with a sufficiently small thickness; electrodes on the IC chip can obviously be connected with the conductive layer pattern without the occurrence of electric short circuiting between the surface of IC chip and the conductive layer pattern; and the IC card embodying the present invention has been experimentally proved to ensure satisfactory operating properties and high reliability.

What is claimed is:

1. An IC card, comprising an insulating core sheet formed of an insulating material and having a main surface, a bottom surface, and at least one through-hole, at least one semiconductor IC chip received within said hole, and having a main surface and a bottom surface, and at least one electrode, and at least one conductive layer pattern deposited on said core sheet, said conductive layer being connected to said electrode; and said semiconductor IC chip being thinner than said core sheet and including at least one conductive projection

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which is formed on said electrode and has top and side surfaces, said semiconductor IC chip being embedded in said core sheet by the insulating material so that the top surface of said conductive projection and the bottom surface of said IC chip are flush with the main surface and bottom surface of the core sheet, respectively; said conductive layer pattern being deposited on the main surface of said core sheet; and the side surface of said conductive projection and only the peripheral portion of the main surface of said IC chip being covered with the material of said core sheet and said conductive layer pattern being connected with said conductive projection at said top surface.

2. The IC card according to claim 1, wherein said conductive projection is prepared from a softer material than said semiconductor IC chip.

3. The IC card according to claim 2, wherein said conductive projection is prepared from at least one metal selected from the group consisting of Au, Cu, Ag, Al, Zn, Pd, Sn, Os, Pt and Ir.

4. The IC card according to claim 2, wherein said conductive projection is made of an alloy prepared from at least two metals selected from the group consisting of Pd, Sn, In, Ag, Ga, Au, Bi, Te, Ge and Sb.

5. The IC card according to claim 2, wherein said conductive projection is prepared from a mass composed of a metal and a resin.

6. The IC card according to claim 1, wherein said core sheet comprises a thermoplastic core sheet, and said conductive projection is formed in such a manner that a distance from the top surface of said conductive projection to that of said semiconductor IC chip is defined to be equal to or longer than a measurement ar-

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rived at by subtracting the thickness of said semiconductor IC chip from that of said thermoplastic core sheet.

7. The IC card according to claim 1, wherein said thermoplastic core sheet is prepared from at least one resin selected from the group consisting of polycarbonate, polyvinyl chloride, polyvinyl chloride-acetate copolymer, polysulfone, polyethylene terephthalate, polyetherketone, polymethylpentene, polyallylate, polyether-sulfone, polyether-imide, polyphenylene-sulfide and ABS.

8. The IC card according to claim 1, wherein said core sheet comprises a thermoplastic core sheet, and said conductive layer pattern is printed on the surface of the thermoplastic resin core sheet by means of conductive paste formed by kneading at least one of the groups consisting of metal powder, metal alloy powder and metal oxide powder with a resin, said metal powder being prepared from at least one metal selected from the group consisting of Au, Ag, Cu, Pt, Ni, Sn, W, Mo, Pd, SiC, C and RuO₂ and said metal alloy powder being formed of a metal alloy composed of at least two of metal group.

9. The IC card according to claim 1, wherein said conductive layer pattern is prepared by depositing at least one metal selected from the group consisting of Au, Ag, Cu, Pt, Ni, Sn, W and Mo on the main surface of said core sheet by one of the following processes: vacuum depositing, sputtering, and electroless plating, and then patterning said deposited metal layer by means of photolithography.

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United States Patent [19]

Champagne et al.

[11] Patent Number: 4,980,802

[45] Date of Patent: Dec. 25, 1990

[54] FLEXIBLE PRINTED CIRCUIT

[75] Inventors: Daniel Champagne, Septeuil; Alain Le Loc'h, Versailles; Olivier Lefort, Vernon, all of France

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[21] Appl. No.: 346,134

[22] Filed: May 2, 1989

[30] Foreign Application Priority Data

May 9, 1988 [FR] France 88 06201

[51] Int. Cl.⁵ H05K 1/18

[52] U.S. Cl. 361/401; 235/488; 235/492; 361/406; 361/408; 361/409

[58] Field of Search 235/487, 488, 492, 493; 361/398, 401, 406, 408, 409, 412

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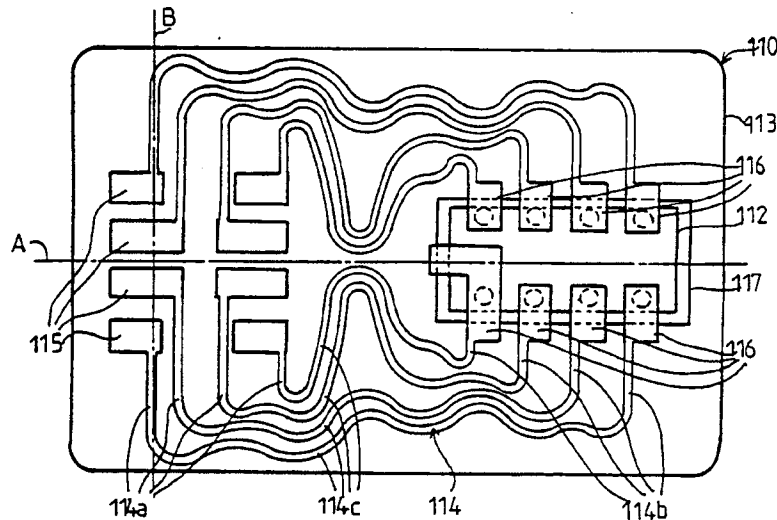
Primary Examiner—Gregory D. Thompson

Attorney, Agent, or Firm—Wolf, Greenfield & Sacks

[57] ABSTRACT

A flexible printed circuit having contacts and associated leads which are connected to the contacts. The contacts are disposed at a first zone and the leads are for connection from this zone to a second zone of the circuit which is at a distance from the first zone. The leads run from the respective contacts substantially perpendicular to the axis of the printed circuit which connects the two zones. The leads in turn form bends or loops in relation to the axis, up to the second zone.

17 Claims, 2 Drawing Sheets



U.S. Patent

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Sheet 1 of 2

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FIG. 1

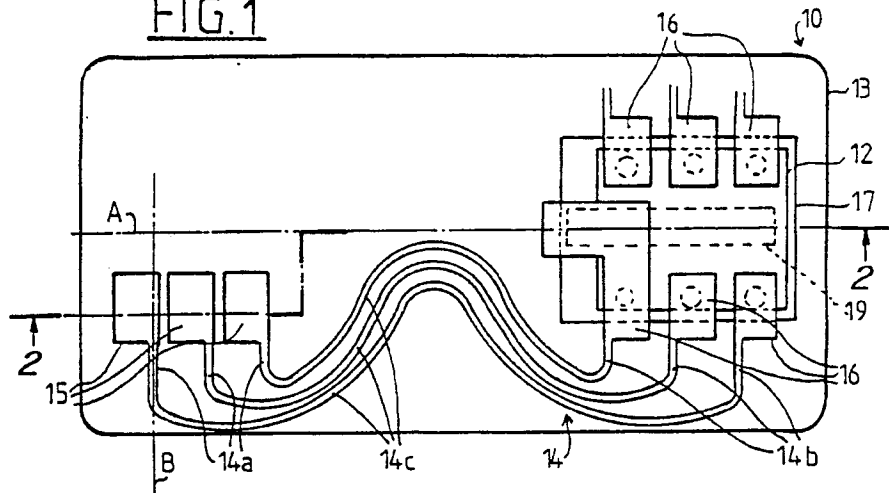


FIG. 2

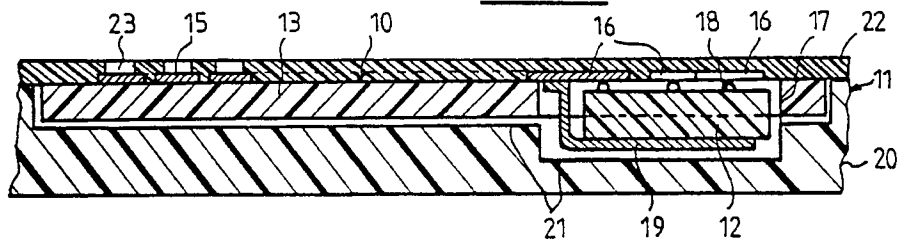
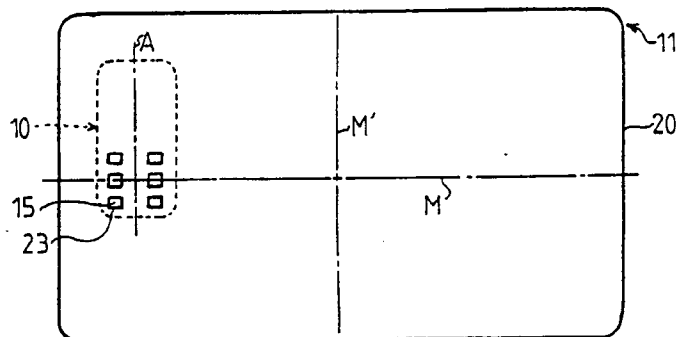


FIG. 3



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FIG. 4

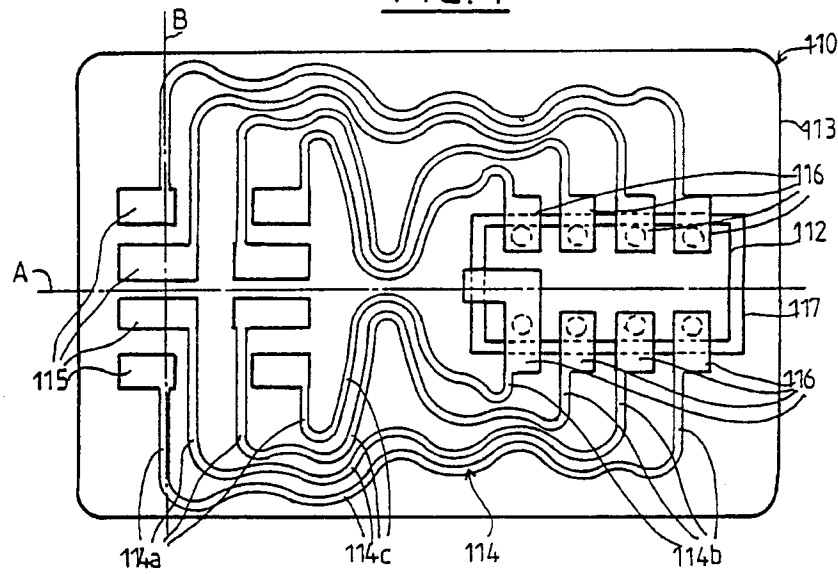
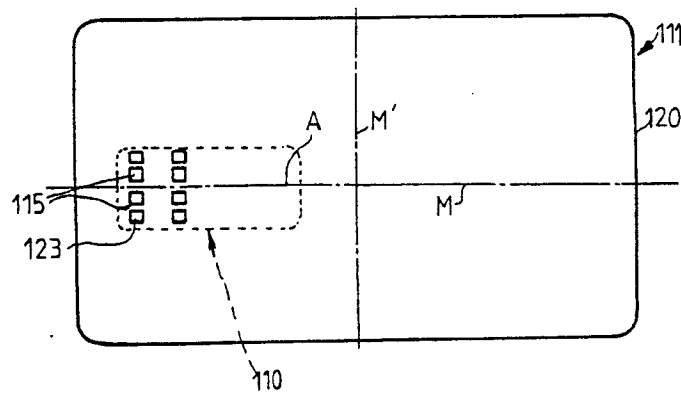


FIG. 5



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FLEXIBLE PRINTED CIRCUIT**BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention relates in general to a flexible printed circuit and pertains, more particularly, to a flexible printed circuit that supports electronic microcircuits for use in a card whose thickness meets the International Standard Organization (ISO) standard for credit cards.

2. Description of Prior Art

A card with electronic microcircuits is a single piece or multilayer rectangular card, made of plastic material. The card has contacts on an exterior surface for connection of the electronic microcircuits (integrated circuit chip) with a device for the processing of the card. These microcircuits may be designed for a variety of different uses, such as, for example, bank debit and credit transactions, the allocation of telephone systems, and confidential access in a protected environment. These cards generally have one or more complex processing and/or memory circuits, depending on the use for which they are intended. In practice, the electronic microcircuits may be comprised of at least one silicon wafer, typically referred to as an integrated circuit or circuit chip.

One form of a card construction is one in which the card is provided with a cavity in which is supported a printed circuit which carries the integrated circuit and, furthermore, carries card contacts. The printed circuit is typically made from a thin sheet of flexible material, such as polyester, epoxy glass, or as well, a plastic material which has sufficient flexibility. Given the fact that the printed circuit, equipped with contacts and an integrated circuit, is to be contained in a card whose thickness, according to standards, is relatively thin, such as $0.762\text{ mm} \pm 10\%$, the sheet for the printed circuit is to be thin, on the order of, for example, 130 micrometers. The flexible material for the sheet and its thinness realize an element which is compatible with the flexibility required by the ISO for cards of the credit card type.

The flexible printed circuit, on one side thereof, carries the integrated circuit, and on the other side thereof carries the card contacts. The contacts are, in this manner, placed at a position remote from the integrated circuit and are connected to terminals of the integrated circuit by leads which are disposed on one side of the flexible printed circuit sheet. For reasons of convenience, the side of the sheet on which the contacts are accessible is termed the upper or external side of the sheet, and the other side of the sheet is termed the lower or internal side thereof. In addition, the axis which connects the card contacts and the integrated circuit is termed the circuit axis.

In accordance with one method of fabricating the flexible printed circuit, the leads and the contacts with which they are connected are disposed on the upper side of the sheet. The terminals of the integrated circuit are soldered to the corresponding ends of the leads, which are arranged overhanging a recessed opening in the sheet. The ends of the leads may be formed in a manner to facilitate their connection with the corresponding terminals on the integrated circuit. A flexible printed circuit constructed in this manner is thin due to the fact that the thickness of the integrated circuit is not added to the thickness of the sheet. This is accom-

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plished primarily by disposing the integrated circuit in a through opening of the sheet.

According to another method of production of the flexible printed circuit, the side of the integrated circuit which is opposite to that which carries the terminals of the integrated circuit is the one which is mounted on the lower side of the sheet, and the terminals of the integrated circuit are therefore connected to the matching ends of the sheet leads by lead wires. This technique employs "wire bonding".

In the production of the flexible printed circuit, the circuit leads may be covered with a protective coating. Alternatively, it is advantageous to spread this coating over the entire side of the card, especially when the leads for the printed circuit run the risk of being located in proximity to, or in contact with, a magnetic strip on the card. It is difficult to lay the magnetic strip if it is not mounted on a homogeneous material. When the coating is employed, of course, in that case openings are provided in the coating in order to provide access to the contacts.

One variant method of production of the printed circuit involves constructing the leads on the lower side of the flexible sheet. The integrated circuit is soldered to the matching lead ends, while, on the other end, the contacts are accessible in recessed openings in the sheet. This variant does not require the use of a coating, but it has the problem of adding to the thickness of the sheet and of the integrated circuit.

Moreover, the staggering of the contacts with respect to the integrated circuit may be preferred for several reasons, especially the need to meet the standards for placement of the contacts on the center line of the card, near one of the shorter edges. Due to this arrangement, the integrated circuit may remain in a corner of the card where torsional and bending stresses are clearly less than at the area of the contacts. ISO standards also dictate that the contacts are to be six or eight in number, distributed in an equal manner in two rows parallel to one of the shorter edges of the card. In accordance with another ISO arrangement, the contacts should have a predetermined minimum surface, rectangular in shape. The leads ordinarily run from the contacts and are connected in a direct and compact fashion with the corresponding terminals of the integrated circuit.

In order to meet international standards, the card has to be capable of enduring, without damage, a given number of flexures, which are performed following one or the other of the center lines of the card. Given this requirement, it has been determined, that printed circuits with staggered contacts designed in the standard manner are generally deficient in meeting minimum standards. As a general rule, the flexures which take place in the direction of the circuit axis are the most damaging. This damage is characterized by breaks in the leads. Studies have, therefore, been undertaken in order to find the best metallurgy and the best method of production for leads. The results obtained have been determined to be unsatisfactory with regard to both quality and reliability.

Accordingly, it is an object of the present invention to provide a flexible printed circuit with the means to ensure the quality of the electrical connections between the contacts and the circuit terminals in a lasting manner, despite the stress created by flexing of the printed circuit.

SUMMARY OF THE INVENTION

To accomplish the foregoing and other objects, features, and advantages of the invention, there is provided a printed circuit for use in a card and in which the printed circuit mounts an integrated circuit and associated contacts. Leads connect at one end to the contacts which are disposed in a first zone. The other ends of the leads couple to a second zone which is at a distance from the first zone. The invention is characterized by the fact that the leads run from respective contacts and in a manner which is substantially perpendicular to the printed circuit axis where the connections are made at the two aforementioned zones. Furthermore, these leads form loops and bends in relation to the axis.

With the structure of the present invention the lengths of leads disposed in a straight line, parallel to the circuit axis, is substantially reduced. In this manner, when the circuit undergoes flexures, the bends give a certain freedom to the leads avoiding them being stretched and thus broken. It has been found that in the worst case, an excessive flexure may possibly entail the ungluing of one of the lead lengths between the contact and the integrated circuit terminal, but a break does not appear, so that electrical continuity is ensured.

The flexible printed circuit arrangement of the present invention is adapted to an installation in which the contacts are near the main center line of the card, in proximity to one of the shorter edges and in which the integrated circuit is likewise near one end of the card. This is illustrated in both the embodiments to be described in further detail hereinafter. However, the concepts of the present invention are also applicable to different installations, such as in the case where the contacts are quite close to the main center line and to one of the shorter edges of the card when the integrated circuit is close to the center of the card, on the main center line. In a more general manner, the invention is applicable to all possible installations in which the circuit axis is parallel to one edge of the card (longer or shorter) and in which the mounting of the contacts on the exterior may or may not satisfy the standards mandated for this field, or even other installations in which the circuit axis is no longer parallel to one or the other edge of the card.

A BRIEF DESCRIPTION OF THE DRAWINGS

Numerous other objects, features, and advantages of the invention should now become apparent upon a reading of the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a top plan view of a first embodiment of a flexible printed circuit in accordance with the present invention;

FIG. 2 is a cross-sectional view taken along line II—II of the flexible printed circuit illustrated in FIG. 1 and illustrating the circuit mounted inside of a card of the credit card type, which is partially illustrated;

FIG. 3 is a top plan view of the entire card, a portion of which is shown in FIG. 2;

FIG. 4 is a top plan view of an alternate embodiment of the flexible printed circuit in accordance with the present invention; and

FIG. 5 is a top plan view of a card embodying the flexible printed circuit of FIG. 4.

DETAILED DESCRIPTION

FIGS. 1–3 illustrate a flexible printed circuit 10 constructed in accordance with the principles of the present invention. The circuit 10 is illustrated for use in a card 11 of the credit card type. The card is of the type to be equipped with electronic microcircuits.

As illustrated in FIGS. 1 and 2, the electronic microcircuits are contained in an integrated circuit 12 which is mounted on the printed circuit 10. The printed circuit 10 is constructed from a rectangular, thin and flexible sheet 13, usually constructed of a plastic material. The upper side of the sheet 13 carries six leads 14, of which only three are totally illustrated for purposes of clarity. The leads 14 connect six contacts 15 to six corresponding tabs 16 which are arranged overhanging a recessed opening 17 in the sheet 13. The opening 17 contains the integrated circuit 12, whose terminals 18 are soldered to the respective tabs 16. In the embodiments illustrated the axis A which connects the zone where the contacts 15 are located to the zone where the tabs 16 are located, is aligned with the main center line of the sheet 13, thus, the axis A of the circuit is here the main center line. In addition, each zone is in proximity to one of the ends of the aforementioned center line.

In the cross-sectional fragmentary view of FIG. 2, the terminals 18 are directly soldered to the tabs 16 of the printed circuit. In an alternate arrangement which is not illustrated, the integrated circuit may be disposed so that the terminals 18 are facing downwardly. In this embodiment, the terminals 18 are therefore connected to the tabs 16 by means of lead wires.

The integrated circuit 12 illustrated in FIGS. 1 and 2 may be of the Metal Oxide Semiconductor (MOS) type. A polarization tab 19 is mounted on the back of the integrated circuit and is connected to an extension of one of the tabs 16. The opening 17 is placed at one end of the rectangular sheet 13 and has its axis aligned with the circuit axis A. The contacts 15 are placed in an area which is remote from the opening 17 and are placed on opposite sides of the axis A at the other end of the sheet 13. The contacts 15 are arranged in two parallel rows, each preferably equidistant from the axis A. Actually, the same type of spacing from the axis A is also provided for the tabs 16.

The contacts 15 and the conductive tabs 16 both have a rectangular shape. The widths of these members are generally orthogonal to the axis A. The leads 14 which connect the contacts 15 to the tabs 16 are thin and narrow in relation to the width of the contacts. For example, the leads 14 may have a width on the order of 300 micrometers.

An example of the manufacturing of an electronic microcircuit card 11 which contains the printed circuit 10 shown in FIG. 1 is illustrated in FIGS. 2 and 3. The card 11 is made of a plate 20 made of flexible material, whose dimensions meet ISO standards. The plate 20 is rectangular in shape, with a large center line M and a small center line M'. It may be a single piece as shown or multilayered. One side of the plate 20 has a cavity 21 which is suitable for housing the printed circuit 10, which is equipped with an integrated circuit 12 so that the upper side of the printed circuit 10 is noticeably coplanar with the corresponding side of the plate 20. The entirety of this side is then covered with a coating 22 with openings 23 in the area of the contacts 15 for their connection to an external processing device. As shown in FIG. 3, one ordinarily takes advantage of the

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printed circuit 10 by placing it in the card 11 in such a manner that the axis A is parallel to one of the shorter edges of the card and the contacts 15 are placed in the vicinity of that same edge, in its middle zone. In the example shown, the contacts 15 which are accessible by means of the openings 23 are distributed from one end to the other of the large center line M of the card.

Now, in accordance with the invention, the leads 14 are illustrated particularly as in FIG. 1 as shown running from respective contacts 15 perpendicularly to the axis A of the printed circuit 10, and then form bends or loops in relation to the axis A. More particularly, each lead 14 has a one portion 14a adjacent to the respective contact 15 and extending in a direction B which is substantially orthogonal or perpendicular to the axis A. At the other end of the lead there is a portion 14b, that interconnected by portion 14c. The portion 14b abuts the corresponding tab 16 and extends in a direction which is also substantially orthogonal or perpendicular to the axis A. But in middle portion 14c, each lead has at least one bend or loop therein in relation to the axis A. A bend or loop is understood to be a non-linear form which has no abrupt angles in the lead's track.

Straight segments of the leads 14, particularly in a direction parallel to the axis A are eliminated particularly in the areas about the contacts 15 and tabs 16, but also, with the loops and bends illustrated the lengths of the leads are thereby increased in relation to the direct path from the contacts 15 to the tabs 16. This makes it possible to compensate for the stretching which occurs during flexing, and prevents the leads from being broken. Furthermore, any angles in the path from the leads would be likely sites for breaks during flexures which would cause buckling at the angles. This is why the lengthening of the path of leads is induced by creating loops or bends which would not be likely breaking points.

FIG. 4 illustrates an alternate embodiment of the invention. In FIG. 4 there is illustrated the printed circuit 110 which carries the integrated circuit 112 and the contacts 115. The contacts 115 are arranged in two rows which are disposed as indicated by the axis B in a direction generally perpendicular to the axis A. The contacts 115 are in a first zone of the thin sheet 113. The connecting tabs 116 are located in a second zone of the sheet 113 which is remote from the first zone. The contacts 115 and the tabs 116 are both in proximity to the axis A as illustrated. Furthermore, in this embodiment the lengths of the individual contacts 115 are in parallel to the axis A of the sheet. The printed circuit 110 of FIG. 4 has elements which are reference 114, 114a, 114b, 114c, 115, 116, and 117. These elements respectively correspond to, and have substantially the same functions as, the elements referenced 14, 14a, 14b, 14c, 15, 16, and 17 in FIGS. 1 and 2.

In the embodiment of the invention illustrated in FIGS. 4 and 5 it is possible to, for example, maintain the standard for installation of the contacts 115 with respect to the card, that is to say, by arranging the rows essentially parallel to each other and to one of the shorter edges of the card. Also, this arrangement permits the integrated circuit 112 to be moved closer to the center of the card as illustrated.

In order to have all of the leads 114 run from the contacts 115 which is in a direction substantially perpendicular to the axis A, the inside contacts close to the axis A have a larger size and in particular a larger length than the outer contacts. The inner contacts 115 thus

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extend beyond the outer contacts as illustrated in FIG. 4, thus facilitating a connection of the leads portions 114a to the contacts, in a direction perpendicular to the axis.

Each lead 114 has a one portion 114a adjacent to the respective contact 115 and extending in a direction B which is substantially orthogonal or perpendicular to the axis A. At the other end of each lead, there is a portion 114b that is interconnected by a portion 114c. The portion 114b abuts the corresponding connecting tab 116 and extends in a direction which is also substantially orthogonal or perpendicular to the axis A. But in metal portion 114c, each lead has at least one bend or loop therein in relation to the axis A. An opening 117 is placed at one end of the rectangular sheet 113 and has its axis aligned with the circuit axis A. The contacts 115 are placed in an area which is remote from the opening 117 and are placed on opposite sides of the axis A at the other end of the sheet 113.

A card 111 which contains such a printed circuit 110 would have, viewed from above, the appearance shown in FIG. 5. In that case, the axis A of the printed circuit 110 would be combined with the large center line M of the card 111 and the contacts 115 would meet current standards. The plate 120 made of flexible material which constitutes the body of the card 111 could have the same structural characteristics as those illustrated in FIG. 3. In particular, it could be covered with a coating with openings 123 in the area of the contacts 115 for their connection with an external processing unit.

In the example shown in FIG. 5, the axis A of the printed circuit overlies the large center line M of the card, so that the integrated circuit 112 is near the center of the card and also on the large center line. It is, of course, possible to use the embodiment shown in FIG. 4 in every instance in which it would be necessary to place the contacts, for example, near a corner of the card, for any reason whatsoever, while observing the arrangement mandated by current standards, and the chip simultaneously near one of the longer edges and a small center line M' of the card.

But it is clearly understood that the illustrations which have been given are not limitative in any way, and, in particular, a change in the standards for the arrangement of the contacts which requires that the rows not be any longer parallel to a shorter edge of the card, but rather parallel to a longer edge of the card, would for example, entail the use of the second embodiment so as to place the contact on the large center line and the chip in the corner or, as well, the first embodiment described might be used in order to position the contacts near one end of the large center line M of the card and the integrated circuit in proximity to the center of the card. Furthermore, it is noted that the contacts 115 may have either their width or their length disposed parallel to the axis A as indicated in FIGS. 1 or 4. In alternate embodiments of the invention the axis of the contacts could also be in other than parallel or perpendicular directions. Also, the contacts need not necessarily be rectangular.

Regardless of the embodiment selected for the placement of the integrated circuit and the contacts, it is desired to avoid placement of the a straight length of lead wire parallel to the axis A of the printed circuit.

The advantages of the invention are the following. According to the ISO standards in which, by convention, a card with electronic microcircuits must undergo without damage a predetermined number of flexures

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made along the large center line M of the card and the same number of flexures along the small center line M'. Experience reveals that flexures of the card which are made on the axis A of the printed circuit are immediately damaging when the printed circuit is made in the standard manner. Breaks occur in the areas of the printed circuit leads, which make all processing of the card impossible or erroneous. A great number of trials have been performed which varied the configuration and the metallurgy of the leads. The arrangement which conforms to the invention ensures in an optimal fashion the reliability of the electrical connection made by the leads in the card when it undergoes a great number of flexures along its two center lines M, M', and which have repercussions along the axis A of the printed circuit.

We claim:

1. A printed circuit comprising: conductive contacts; and conductive leads which are each connected to a respective contact at a first zone of the circuit, and which are each connected to a respective second contact in a second zone, said second zone of the circuit located at a distance from the first zone, each lead having means defining end portions that extend to a predetermined point from the respective contact in each of the first and second zones in a direction substantially perpendicular to an axis of the printed circuit defined as that axis extending between the first and second zones, and each lead also including means defining a middle portion contiguous with each of the end portions at the predetermined point, said middle portion having at least one bend or loop therein.

2. A printed circuit in accordance with claim 1, wherein the contacts are distributed in the first zone in two rows which are parallel to the axis of the printed circuit.

3. A printed circuit in accordance with claim 2, wherein the leads end in the second zone in a direction which is substantially perpendicular to the axis, and wherein each lead ends at a different tab located in said second zone.

4. A printed circuit in accordance with claim 1, wherein the contacts are distributed in the first zone in a uniform manner along the axis of the printed circuit.

5. A printed circuit in accordance with claim 4, wherein the leads end in the second zone in a direction which is substantially perpendicular to the axis, and wherein each lead ends at a different tab located in said second zone.

6. A printed circuit in accordance with claim 1, wherein the leads end in the second zone in a direction which is substantially perpendicular to the axis, and wherein each lead ends at a different tab located in said second zone.

7. A printed circuit in accordance with claim 6, wherein the tabs are distributed in the second zone in a uniform manner along the axis of the printed circuit.

8. A printed circuit in accordance with claim 6, further comprising an integrated circuit carried in the second zone and provided with terminals, each of the terminals being connected with one of the tabs.

9. A printed circuit in accordance with claim 8, wherein the integrated circuit is placed in an opening made in the second zone.

10. A printed circuit in accordance with claim 1, wherein the contacts in at least one of said first and second zones are distributed in two rows which are parallel to each other and which rows extend perpen-

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dicular to the axis of the circuit, thus placing some contacts closer to the said axis and some contacts further away from said axis and wherein said contacts which are closer to said axis have a dimension, parallel to the axis, which is larger than the corresponding dimension of the contacts which are further away from said axis such that all of the contacts are each accessible by a respective lead.

11. A printed circuit comprising: conductive contacts, and conductive leads, which are each connected to a respective contact at a first zone of the circuit, and which are each connected to a respective second contact in a second zone of the circuit, said second zone of the circuit located at a distance from the first zone, wherein each lead runs to a predetermined point from each respective contact it is connected to in a direction substantially perpendicular to an axis of a printed circuit defined as that axis extending between said first and second zones, said leads furthermore having bends or loops therein disposed between each predetermined point, and wherein the contacts in at least one of said first and second zones are distributed in two rows which are parallel to each other and which rows extend perpendicular to the axis of the circuit, thus placing some contacts closer to the said axis and some contacts further away from said axis, and wherein said contacts which are closer to said axis have a dimension, parallel to the axis, which is larger than the corresponding dimension of the contacts which are further away from said axis such that all of the contacts are each accessible by a respective lead.

12. A printed circuit in accordance with claim 3, wherein the leads end in the second zone in a direction which is substantially perpendicular to the axis, and wherein each lead ends at a different tab located in said second zone.

13. A card having an electronic microcircuit thereon, said microcircuit being a printed circuit comprising: conductive contacts; and conductive leads which are each connected to a respective contact at a first zone of the circuit, and which are each connected to a respective second contact in a second zone, said second zone of the circuit located at a distance from the first zone, each lead having means defining end portions that extend to a predetermined point from the respective contact in each of the first and second zones in a direction substantially perpendicular to an axis of the printed circuit defined as that axis extending between the first and second zones, and each lead also including means defining a middle portion contiguous with each of the end portions at the predetermined point, said middle portion having at least one bend or loop therein.

14. A card in accordance with claim 13, wherein: the card is substantially quadrilateral in shape, the quadrilateral shape having first and second center lines substantially perpendicular to each other; the axis is parallel to the first center line of the card; and the contacts are located in the vicinity of the second center line of the card.

15. A card in accordance with claim 13, wherein: the card is of a substantially rectangular shape having two perpendicular center lines of different length; the axis is substantially parallel to the shorter edges of the card and to the shorter center line; and the contacts are located in the vicinity of the longer center line of the card, near one of its ends.

16. A card in accordance with claim 13, wherein: the card is of substantially rectangular shape having two

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perpendicular center lines of different length; the axis overlies the longer center line of the card; and the contacts are in proximity to one end of the longer center line.

17. In combination, a card and a flexible printed circuit supported within the card and having contacts which are disposed in a first zone of the circuit and a circuit chip which is disposed in a second zone of the circuit spaced from said first zone, the printed circuit comprising: conductive leads intercoupling the contacts and the circuit chip, said conductive leads having ends thereof located at each of the contacts and circuit chip

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and extending from each of said ends to predetermined points in a direction substantially orthogonal to an axis of the printed circuit that extends between said zones, said leads having bends or loops therein between said predetermined points, wherein the contacts are distributed in two rows which are parallel to each other and perpendicular to the axis of the circuit, and wherein the inner disposed contacts are longer than the outer disposed contacts of each row to facilitate a perpendicular connection of the conductive leads and contacts.

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United States Patent [19]

Yanaka et al.

[11] **Patent Number:** 5,067,008[45] **Date of Patent:** Nov. 19, 1991[54] **IC PACKAGE AND IC CARD
INCORPORATING THE SAME THEREINTO**[75] **Inventors:** Yoshimi Yanaka, Toride; Keiji
Miyamoto, Ibaraki, both of Japan[73] **Assignee:** Hitachi Maxell, Ltd., Osaka, Japan[21] **Appl. No.:** 563,628[22] **Filed:** Aug. 7, 1990[30] **Foreign Application Priority Data**

Aug. 11, 1989 [JP] Japan 1-209360

[51] **Int. Cl.⁵** H01L 23/02[52] **U.S. Cl.** 357/81; 357/80;
357/72; 357/14; 357/77[58] **Field of Search** 357/72, 84, 80, 81,
357/77, 74; 235/272.17, 492, 441; 264/272.17[56] **References Cited****U.S. PATENT DOCUMENTS**

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Patent Abstracts of Japan, vol. 12, no. 65 (E-586) (2912), Feb. 27, 1988; and JP-A-62-208 651 (Mitsubishi) 12-09-1987.

Primary Examiner—Andrew J. James*Assistant Examiner*—T. Davenport*Attorney, Agent, or Firm*—Birch, Stewart, Kolasch, & Birch[57] **ABSTRACT**

An IC package comprising an integrated substrate which includes a cavity, in which an IC chip is mounted, formed by a wall surrounding the IC chip, and a groove formed in the surrounding wall extending to surround and communicate with the cavity and method for fabricating the IC package, wherein an excessive amount of resin is filled in the cavity of the integrated substrate, and the composite structure pressed by a plate whereby the excess of the resin overflows from the cavity pressure to be received in the groove such that, the exposed surface of the filled resin is formed into a predetermined shape without requiring grinding.

13 Claims, 5 Drawing Sheets

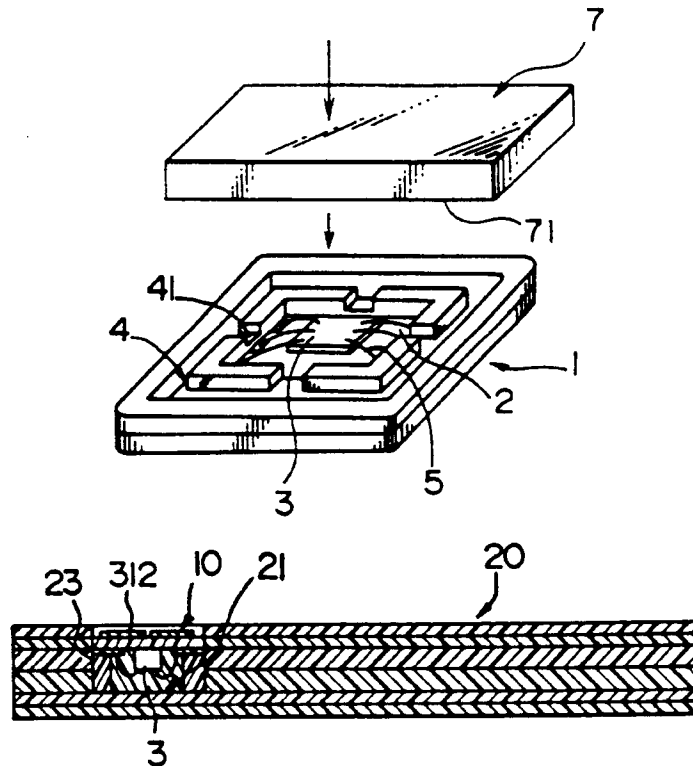


FIG. 1

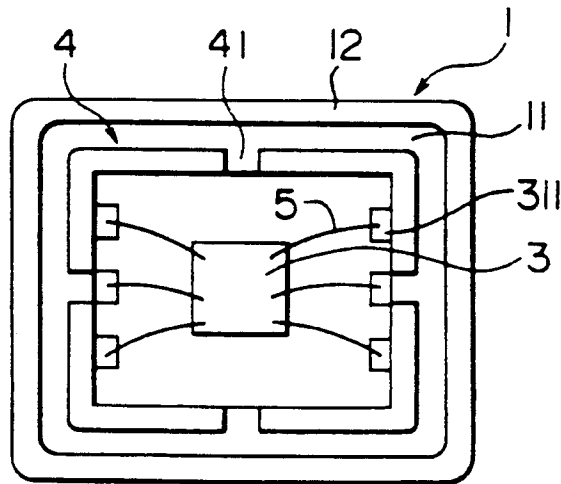


FIG. 2

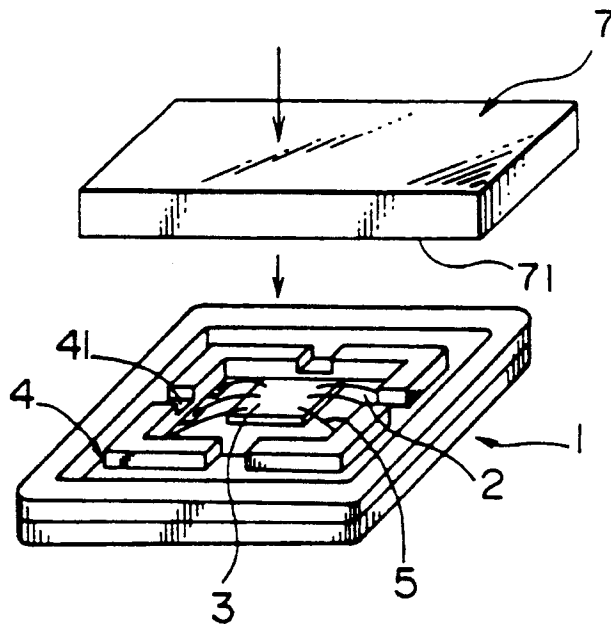


FIG. 3

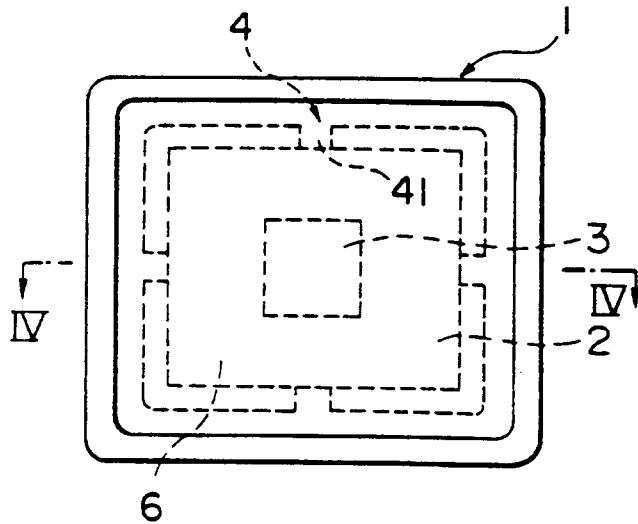


FIG. 4

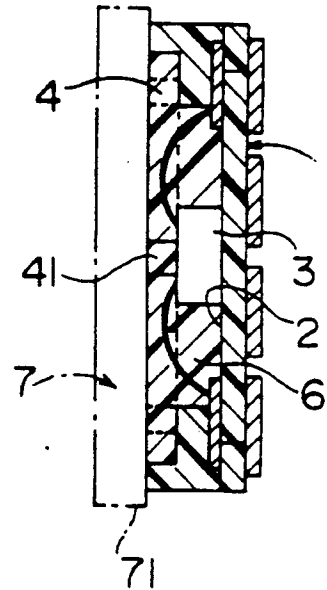


FIG. 5

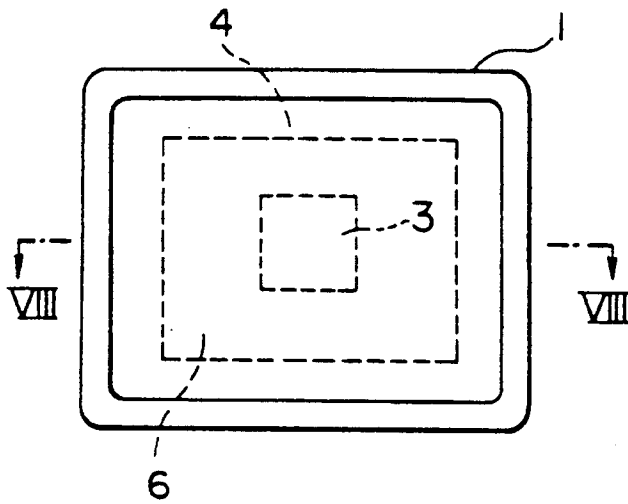


FIG. 8

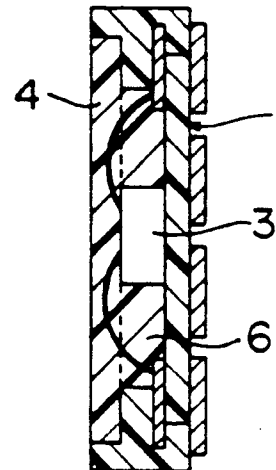


FIG. 6

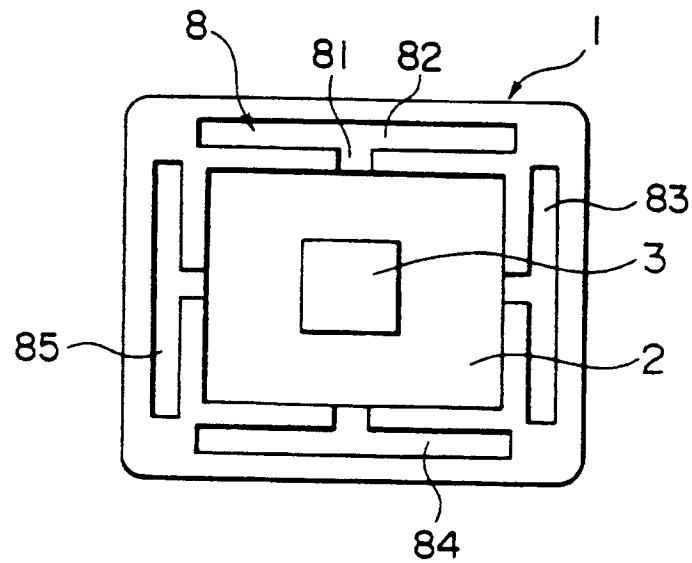


FIG. 7

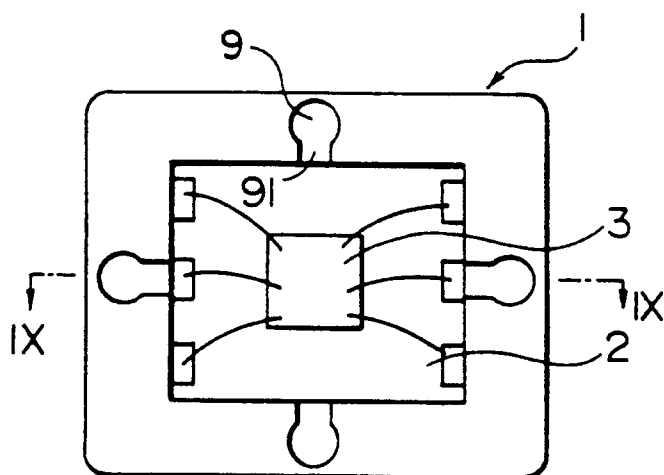


FIG. 9

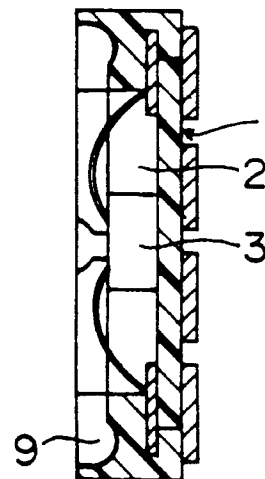


FIG. 10

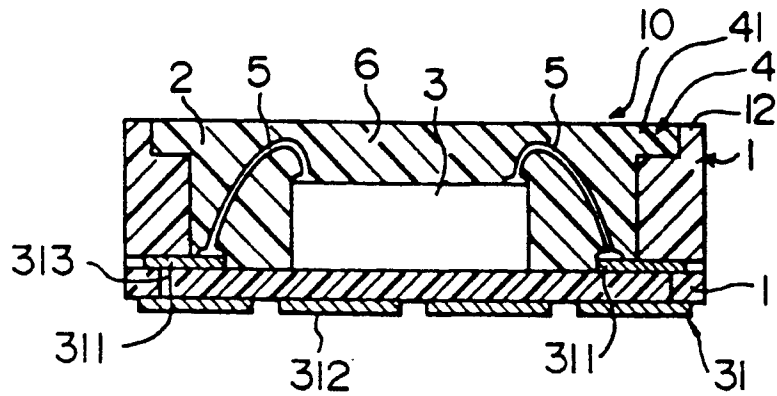


FIG. 11

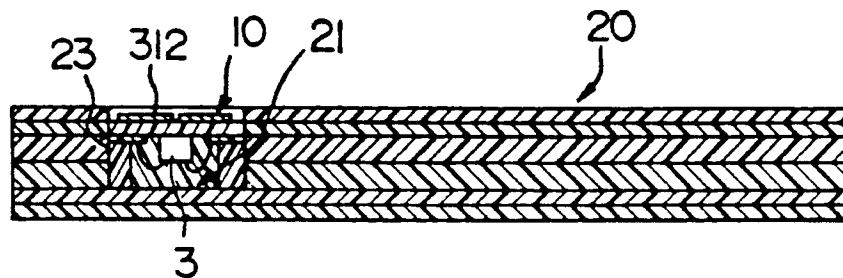
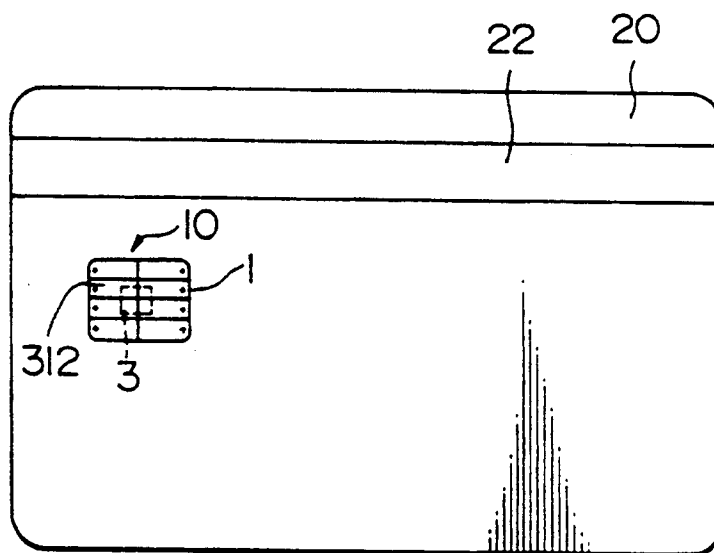


FIG. 12



IC PACKAGE AND IC CARD INCORPORATING THE SAME THEREINTO

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an IC (integrated circuit) package and also to an IC card incorporated.

2. Discussion of the Related Art

In the production of a conventional IC package a surrounding wall is placed on an IC package substrate to define therebetween a cavity. An IC chip is placed within the cavity of the IC package substrate. A wire bonding is provided between the IC chip and terminals. A excess amount of a liquid viscous resin material is filled into the cavity by potting. Examples of such a liquid viscous resin material include an epoxy resin and a silicone resin. After the resin is cured or set, the excess of the resin is removed by grinding, thereby adjusting the flatness and thickness of the IC package.

However, recently, to meet the requirement for saving power consumption of an IC package and the requirement for compactness of the IC package, the IC package substrate, as well as the potted resin, has become thinner. As a result, there have been encountered problems, such as the generation of stresses in the IC chip and disconnection of bonding of gold wires because of the grinding operation.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide an IC package requiring no grinding operation.

According to the present invention, there is provided an IC package comprising:

an integrated circuit chip;

a substrate on which the integrated circuit chip is mounted;

a wall for surrounding the integrated circuit chip, the surrounding wall being placed on the substrate to define therebetween a cavity in which the integrated circuit chip is mounted on the substrate;

recess means provided in the surrounding wall, the recess means communicating with the cavity; and

a resin which fills the cavity and recess for sealing the integrated circuit chip therein.

According to the present invention, when an excessive amount of resin is filled in the IC package, the excess of resin which does not contribute to the plastic-sealing of the IC chip spills over into the recess means. Therefore, without the use of a grinding operation, there can be produced an IC package having a degree of flatness and a high precisely controlled thickness. Since the grinding operation is not needed, the above-mentioned problems are not encountered, and the IC package can be produced at lower costs with a higher yield.

Preferably, the capacity of the recess means is substantially equal to a volume corresponding to a difference between the maximum volume of the resin to be filled and a volume of the resin required for the potting, and the capacity of the recess means is not more than 10% of the maximum volume of the resin to be filled.

Other objects, operation and features of the present invention will become apparent to those skilled in the art upon making reference to the following detailed description of the preferred embodiments and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of an integrated substrate to be used in an IC package according to one embodiment of the present invention;

FIG. 2 is a view illustrative of a method of producing an IC package incorporating therein the substrate shown in FIG. 1;

FIG. 3 is a top plan view of the integrated substrate of FIG. 1 subjected to potting with a resin;

FIG. 4 is a cross-sectional view taken along the line IV—IV of FIG. 3;

FIGS. 5, 6 and 7 are top views showing modified integrated substrates used in other embodiments of the present invention, respectively;

FIGS. 8 and 9 are cross-sectional views taken along the line VIII—VIII of FIG. 5 and the line IX—IX of FIG. 7, respectively;

FIG. 10 is a cross-sectional view showing an IC package incorporating therein the substrate shown in FIG. 1;

FIG. 11 is a cross-sectional view showing an IC card incorporated into the IC package shown in FIG. 10; and

FIG. 12 is a plan view showing the IC card shown in FIG. 11.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a substrate 11 for an IC (integrated circuit) package has a rectangular shape (7 mm×9 mm). A surrounding wall 12 is mounted on the substrate 11 so as to define therebetween a cavity 2. The substrate 11 and the surrounding wall 12 are made of epoxy resin with a glass fiber filler, integrated into an integrated substrate 1. The integrated substrate 1 has a thickness of 0.8 mm. The surrounding wall 12 has a continuous groove 4 therein extending to surround the cavity 2. The groove 4 has a width of 0.2 mm and a depth of from 0.1 mm to 0.2 mm. The groove 4 communicates with the cavity 2 through four communication passages 41. The groove 4 and passages 41 comprise together a resin means.

A method of forming a package for an IC card using the integrated substrate 1 of FIG. 1 will now be described with reference to FIGS. 2 to 4 and 10.

First, the IC chip 3 is placed at a central portion of the substrate 11. The substrate 11 incorporates a wiring board 31 (FIG. 10) having lead terminals 311 and input/output terminals 312, both of which terminals 311 and 312 are electrically connected with each other through communication holes 313 formed in the substrate 11. The IC chip 3 is connected or wire-bonded with the lead terminals 311 through gold wires 5, as shown in FIG. 10.

Then, the cavity 2 is filled with a viscous resin material 6 (for example, epoxy resin or silicone resin) in a liquid state in an amount in excess of the volume of the cavity 2. Subsequently, a pressure plate 7 is abutted at its flat smooth surface 71 against the resin 6, and is pressed against the integrated substrate 1. The excess of the resin 6 overflows from the cavity 2 into the groove 4 via the communication passages 41. Then, an ultraviolet ray is applied to set or cure the resin 6. After the resin 6 is completely cured, the pressure plate 7 is released from the integrated substrate 1.

With this method, an IC package 10 can be obtained, in which the exposed surface of the cured resin 6 is

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formed to a high degree of flatness, without grinding (FIG. 10).

In the case whereby the IC package 10 thus produced according to the above-mentioned procedure is incorporated into an IC card, a card body 20 of a multilayer laminate is provided at first, shown in FIGS. 11 and 12. The card body 20 is provided with a recess 21 for the IC package 10 and on one end surface thereof with a magnetic strip 22. An adhesive 23, for example an epoxy resin, is applied to an inner periphery of the recess 21 of the card body 20 and the IC package 10 is inserted into the recess 21 such that the input/output terminals 312 are located to be facing outward. Subsequently, pressure is applied to the IC card body 20 under a moistened condition to cure the adhesive 23 to produce the IC card.

In this embodiment, in order to facilitate the release of the pressure plate 7 from the substrate 1, the pressure plate 7 is made of polytetrafluoroethylene. However, any other suitable material which facilitates this release can be used. For example, the press plate 7 may comprise a glass plate coated with silicone. Also, the abutment surface 71 of the pressure plate 7 may be satin finished or corrugated, instead of flat and smooth one. In this case, an anchor effect of an adhesive can be enhanced when bonding the package to a mating device or element.

The effective capacity of the groove 4 and passages 41 is substantially equal to a volume corresponding to a difference between the maximum volume of the resin to be filled and a volume of the resin required for the potting. In this embodiment, the effective capacity of the groove 4 and passages 41 is substantially equal to 10% of the volume of the resin filled, which volume is about 30 mg.

FIGS. 5 and 8 show another embodiment of the invention which differs from the embodiment of FIGS. 3 and 4 only in that the inner peripheral surface of the groove 4 is expanded or extended to the outer periphery of the cavity 2.

FIG. 6 shows a further embodiment of the invention. In this embodiment, groove means 8 is composed of four discontinuous groove portions 82 to 85 disposed to surround the cavity 2. Each of the groove portions 82 and 85 communicates with the cavity 2 through a respective one of communication passages 81.

In a further embodiment shown in FIGS. 7 and 9, instead of the groove, a plurality of dimples 9 are formed in the surrounding wall 12. Each of the dimples 9 communicates with the cavity 2 through a respective one of the communication passages 91.

These modified substrates achieve similar effects achieved by the substrate of FIG. 1. The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:

1. An IC package comprising:
an integrated circuit chip;
a substrate on which said integrated circuit chip is mounted;

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a wall for surrounding said integrated circuit chip provided on said substrate to define therebetween a cavity;

recess means provided in said surrounding wall for communicating with said cavity; and
resin for filling said cavity and said recess means for sealing said integrated circuit chip.

2. An IC package according to claim 1, wherein a difference between a volume of resin to be filled into said cavity and a maximum desired volume of resin to be filled is less than 10% of said maximum desired volume of resin to be filled.

3. An IC package according to claim 1, wherein an effective capacity of said recess means is substantially equal to a volume corresponding to a difference between a maximum volume of filled resin and a volume of resin to be potted.

4. An IC package according to any one of claims 1, 2 and 3, wherein said recess means includes either one continuous groove or a multiplicity of grooves surrounding said integrated circuit chip.

5. An IC package according to any one of claims 1, 2 and 3, wherein said recess means includes a plurality of dimples.

6. An IC card comprising:

an IC card body provided with a recess portion; and
an IC package fixed into said recess portion of said IC card body, said IC package including,
an integrated circuit chip;

a substrate on which said integrated circuit chip is mounted;

a wall for surrounding said integrated circuit chip provided on said substrate to define therebetween a cavity;

recess means provided in said surrounding wall for communicating with said cavity; and
resin for filling said cavity and said recess means for sealing said integrated circuit chip.

7. An IC card according to claim 6, wherein a difference between a volume of resin to be filled into said cavity and a maximum desired volume of resin to be filled is less than 10% of said maximum desired volume of resin to be filled.

8. An IC card according to claim 6, wherein an effective capacity of said recess means is substantially equal to a volume corresponding to a difference between a maximum volume of filled resin and a volume of resin to be potted.

9. An IC card, according to any one of claims 6, 7 and 8, wherein said recess means includes either one continuous groove or a multiplicity of grooves surrounding said integrated circuit chip.

10. An IC card according to any one of claims 6, 7 and 8, wherein said recess means includes a plurality of dimples.

11. An IC card according to claim 6, wherein said IC package is fixed to said IC card body by an adhesive layer.

12. An IC package according to claim 1, wherein said recess means includes a groove in said wall surrounding said integrated circuit chip and passages for communicating with said cavity.

13. An IC card according to claim 6, wherein said recess means of said IC package includes a groove in said wall surrounding said integrated circuit chip and passages for communicating with said cavity.

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United States Patent [19]

Champagne et al.

[11] Patent Number: 5,097,117

[45] **Date of Patent:** Mar. 17, 1992

- [54] **ELECTRONIC MICROCIRCUIT CARD AND METHOD FOR ITS MANUFACTURE**
- [75] **Inventors:** Daniel Champagne, Septeuil; Alain Le Loc'h, Versailles, both of France
- [73] **Assignee:** Bull CP8, Trappes, France
- [21] **Appl. No.:** 342,537
- [22] **PCT Filed:** Jul. 1, 1988
- [86] **PCT No.:** PCT/FR88/00350
- § 371 Date: Feb. 27, 1989
- § 102(e) Date: Feb. 27, 1989
- [87] **PCT Pub. No.:** WO89/00340
- PCT Pub. Date:** Jan. 12, 1989
- [30] **Foreign Application Priority Data**
- Jul. 2, 1987 [FR] France 87 9380
- [51] **Int. Cl.⁵** G06K 19/02; G06K 19/06
- [52] **U.S. Cl.** 235/488; 235/492
- [58] **Field of Search** 235/487, 488, 492; 361/397, 398, 400, 402; 357/72, 74; 29/831, 841
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Primary Examiner—Stuart S. Levy

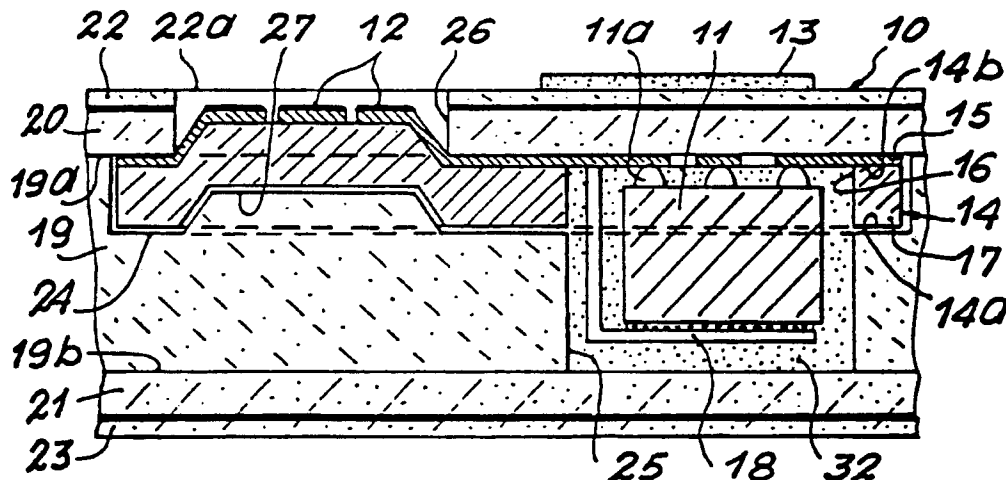
Assistant Examiner—Tan Nguyen

Attorney, Agent, or Firm—Kerkam, Stowell, Kondracki & Clarke

[57] **ABSTRACT**

An electronic microcircuit card and method for its manufacture are disclosed. Contacts 12 that are accessible through an opening 26 of the card 10 are raised by a boss 27 formed under the contacts in such a manner that they come approximately to the level of the outer face 22a of the card. The invention applies particularly to credit cards, the thickness of which meets the standard for credit cards as established by the International Standards Organization (ISO).

13 Claims, 3 Drawing Sheets



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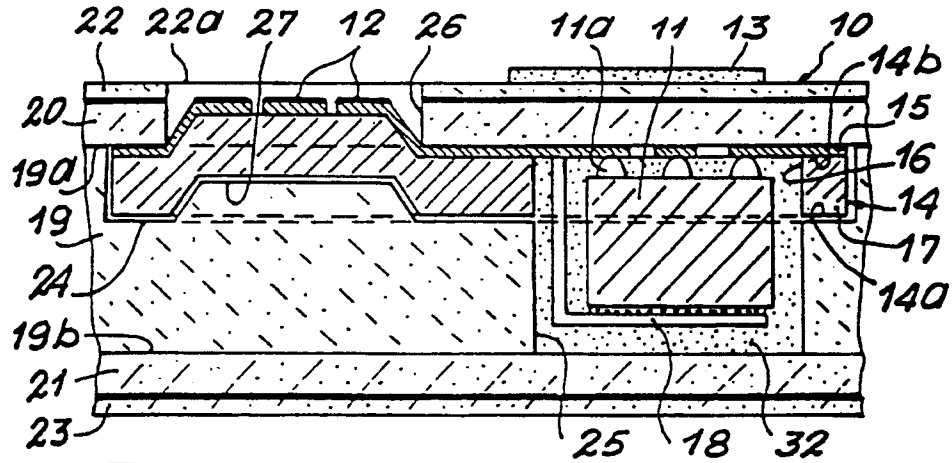


FIG. 1

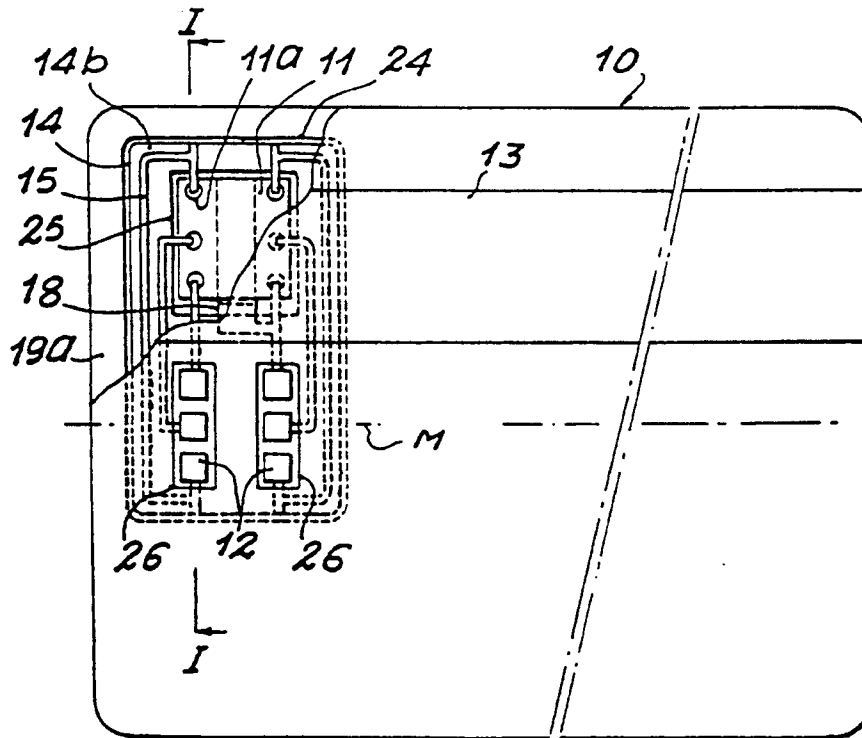


FIG. 2

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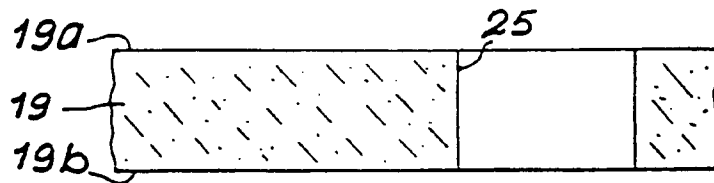


FIG. 3A

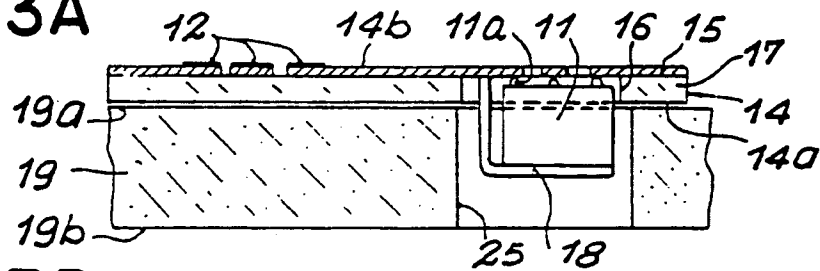


FIG. 3B

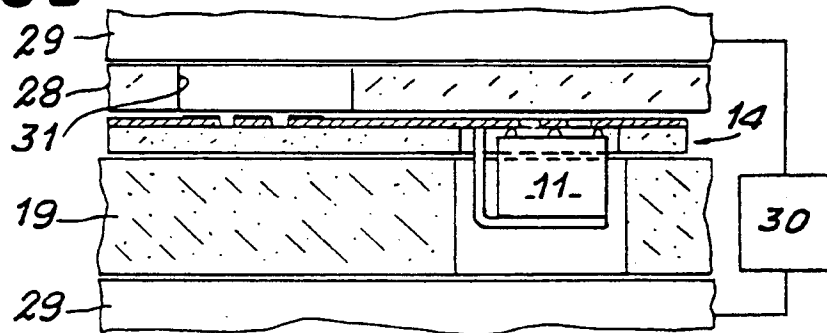


FIG. 3C

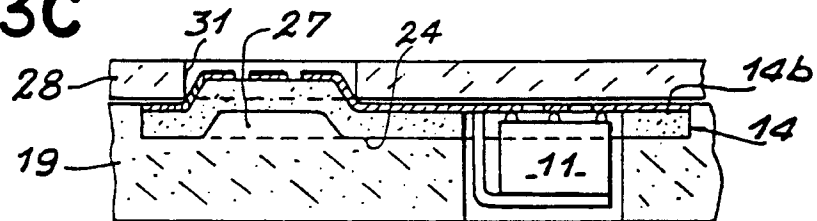


FIG. 3D

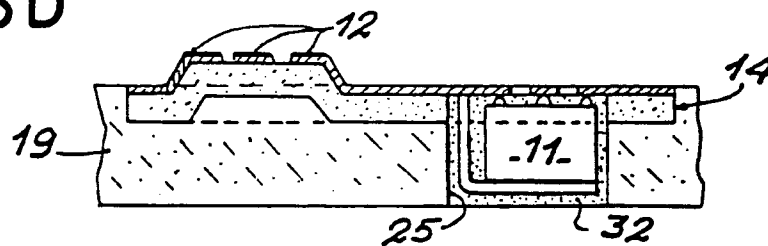


FIG. 3E

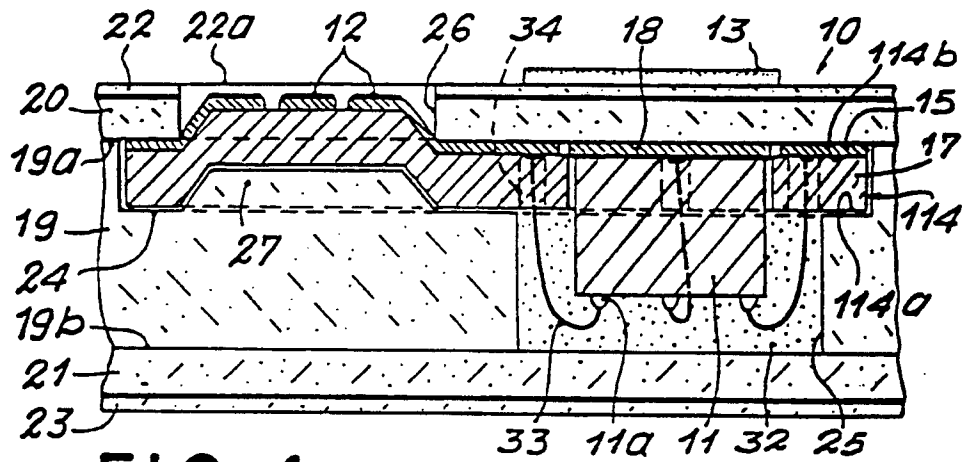


FIG. 4

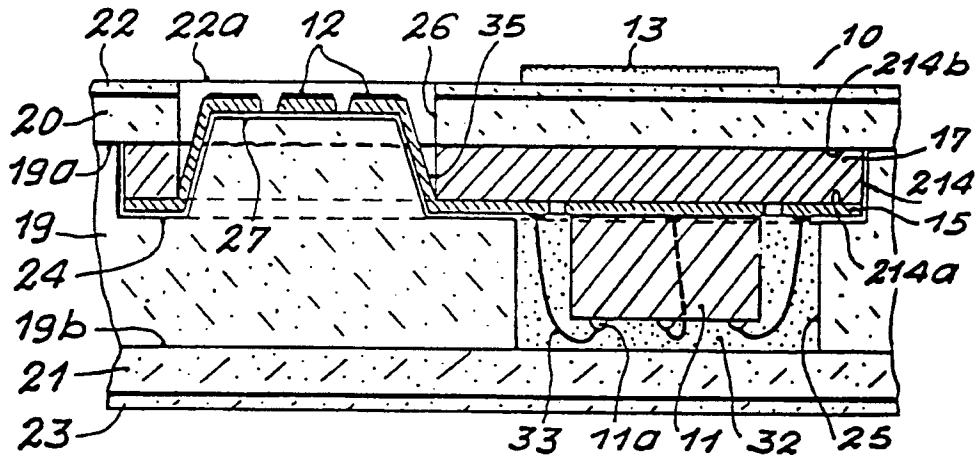


FIG. 5

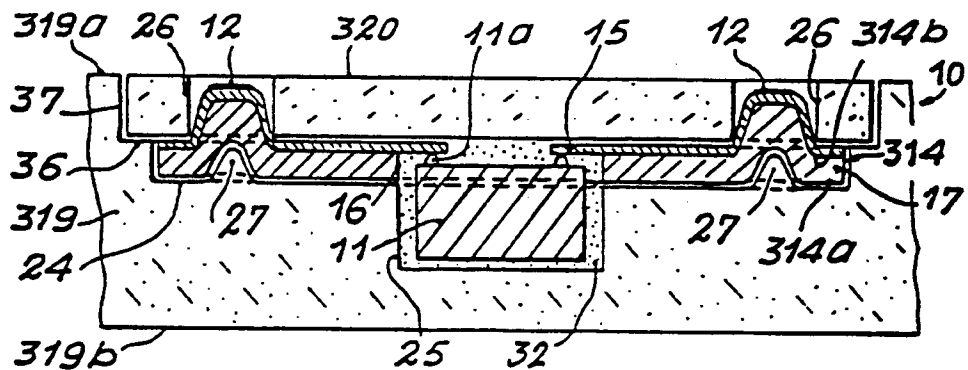


FIG. 6

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ELECTRONIC MICROCIRCUIT CARD AND METHOD FOR ITS MANUFACTURE

The invention relates to an electronic microcircuit card and a method for manufacturing it. More particularly, it applies to the manufacture of a portable card the thickness of which meets the standard for credit cards of the International Standards Organization (ISO).

An electronic microcircuit card is a small rectangular one-piece or multi-layer plate of plastic material, which incorporates electronic microcircuits and on its outside has contacts for the connection of the electronic microcircuits with a card processing apparatus. These microcircuits may be intended for quite various functions, for instance such banking operations as debiting and crediting, billing of telephone call units, and confidential input into a secure medium. Typically, they comprise processing circuits and/or memory circuits which are more or less complex depending on their intended use. In practice, they are formed on at least one small silicon plate, currently known as an integrated circuit or chip.

The invention applies in particular to a card such as that described in French Patent No. 2 337 381 (U.S. Pat. Nos. 4,216,577 and 4,222,516), for example, of the present Applicant. One face of a printed circuit is provided with an integrated circuit, and the other face has the contacts of the card. In an exemplary embodiment, the card is made simply of a one-piece small plate, one face of which gradually has a peripheral indented zone, beginning at a deep cavity, and a step surrounding the indented zone. The integrated circuit is accommodated in the cavity, and the printed circuit is distributed over the indented zone. A foil covering the printed circuit and thus forming a cover cap is affixed to the step. The foil has its outer face substantially coplanar with the corresponding face of the small plate and includes openings that correspond with the contacts of the printed circuit. The use of the card is thus accomplished by connecting the contacts via the openings in the foil.

In a variant embodiment described in the prior art patent named above, the small plate has no indented step, and the foil covering the printed circuit covers the entire corresponding face of the small plate. Thus the card comprises the small plate and the foil. The contacts remain accessible through openings in the foil.

Another variant embodiment is described in European Patent Application No. 0 207 852, for example, of the present Applicant. The printed circuit is made of a thin ribbon, the end of one face of which has the integrated circuit and the other end of the other face of which has the contacts of the card. Thus the contacts are offset relative to the integrated circuit. This arrangement may be preferred for several reasons, in particular in order to meet the standards for placement of contacts on the long median of the card. Because the printed circuit has offset contacts, the integrated circuit can remain in one corner of the card, where the strains of flexion and torsion are markedly less than at the level of the contacts. However, if the printed circuit is to be attained simply and at low cost, it must be covered with a foil provided with openings corresponding with the contacts. The foil may simply be a cover cap, or may extend over the entire face of the small plate.

These exemplary embodiments demonstrate that often the manufacture of an electronic microcircuit card requires the use of a foil provided with openings, for access to the contacts of the card that are carried by

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the printed circuit. The thickness of the foil for access to the contacts has several disadvantages. First, numerous applications of the card require that a finishing film be applied to the foil; second, to lend the foil good mechanical strength, so as to protect the printed circuit, the minimum thickness of the foil must be relatively great. It follows that the contacts are located at a relatively great depth in the surface of the card, for example a depth greater than 0.1 mm. Considering the various methods of manufacture of cards that can be used by an apparatus, the connector of this apparatus must adapt to as wide a range of depths as possible, while assuring effective and reliable connection. Standards have been promulgated for limiting the maximum depth of the contacts to a relatively low value. The problem then posed is to raise the contacts within the openings in order to meet the standards and, if possible, to the contacts practically at the level of the surface of the

The solution at present for raising the contacts in the openings comprises providing an accretion of copper on the contact zones that correspond with the openings. This accretion is generally accomplished by electrochemical copper plating, which requires the use of a time-consuming and expensive technology that is little used.

The invention offers a simple and relatively inexpensive solution to the problem of raising the contacts in the openings of a card.

An electronic microcircuit card die includes: a printed circuit one face of which carries an integrated circuit and the other face has contacts; a small plate, one face of which has a plane zone covered by the printed circuit, and a cavity for accommodating the integrated circuit; and a foil that covers at least the printed circuit and gives access to the contacts via at least one opening; characterized in that the zone includes a boss under the opening of the foil.

A method of manufacture of a card in accordance with the invention, including the placement of a printed circuit on one face of a small plate of plastic material provided with a cavity for accommodating an integrated circuit, and the covering of the printed circuit with a foil having a predetermined surface area and giving access to contacts of the printed circuit via at least one opening, is characterized in that prior to the covering, the method comprises: making the cavity in a uniformly plane field, having said predetermined surface area of the foil, of said face of the small plate; disposing a die, embodied by a plane blade that is a good thermal conductor and is provided with an opening corresponding to said opening of the foil and covering at least the printed circuit, above the printed circuit; heating the small plate to a molding temperature; pressing the die far enough that the upper face of the printed circuit is approximately coplanar with said field of the small plate, thus creating an indented zone in the small plate for the emplacement of the printed circuit, the zone being provided with a boss under the opening of the die; and withdrawing the die.

The characteristics and advantages of the invention will become apparent from the ensuing detailed description of an exemplary embodiment, taken in conjunction with the drawings.

In the drawings:

FIG. 1 is a fragmentary sectional view along the line I—I in FIG. 2, showing an exemplary embodiment of a card according to the invention;

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FIG. 2 is a plan view of a detail of the card shown partially in FIG. 1;

FIGS. 3A-3E are sectional views illustrating the steps in the manufacture of the card shown in FIGS. 1 and 2;

FIG. 4 is a view similar to that of FIG. 1 illustrating a first variant embodiment of a card according to the invention;

FIG. 5 is a view similar to that of FIG. 1 illustrating a second variant embodiment of a card according to the invention; and

FIG. 6 is a view similar to that of FIG. 1, illustrating a third variant embodiment of a card according to the invention.

FIGS. 1 and 2 illustrate the preferred embodiment of an electronic microcircuit card 10 according to the invention, of the standardized credit card type. The electronic microcircuits are assumed to be included in a single integrated circuit 11 and are accessible via six pads 11a. One face of the card 10, of rectangular shape, has six contacts 12 for the connection of the integrated circuit 11 to a card processing apparatus, not shown. The same face of the card includes a magnetic tape 13 that carries data. By the standards selected as an example, the magnetic tape 13 is close to one long side of the card, and the contacts 12 are placed in a zone that intersects or adjoins the long median M of the card in proximity with a short side.

In the conventional manner, the card 10 includes a printed circuit 14 one face 14a of which carries the integrated circuit and the other face 14b has the contacts 12. Conductors 15 on the face 14b respectively connect the six contacts 12 to the six pads 11a of the integrated circuit 11 by the well known TAB technique (tape automated bonding). Thus the pads 11a of the integrated circuit 11 are welded to the ends mounted overhanging the conductors 15 about a window 16 of the insulating substrate 17 of the printed circuit 14. The substrate 17 is typically of a plastic material such as that known by the registered trademark "Kapton", on the order of 130 micrometers (μm) thick. The contacts 12 and the conductors 15 are ordinarily made beginning with the same metal layer of copper applied to the substrate 16 of the printed circuit. The contacts 12 are then formed by the deposition of a film of gold on at least one intermediate compatibility layer; all of these layers are represented in FIG. 1 by a solid line. Assuming that the integrated circuit 11 is of the MOS type (metal oxide semiconductor), one of the conductors 15 is extended by a polarization lead 18 affixed to the back face of the integrated circuit, for example by means of a silver-based conductive glue. Thus the printed circuit 14 shown is the type having offset contacts.

Again in the conventional manner, the card 10 is assumed to be embodied by a small central plate 19, also known as a core, the two large faces 19a, 19b of which are covered with two foils 20, 21 and two films 22, 23, respectively. The small plate and the two foils are generally made of a flexible plastic such as PVC (polyvinyl chloride). The foils are of equal thickness and are thin with respect to the plate, for example in a ratio of 130 μm : 500 μm . In numerous applications, the foils are printed, so that all the informations desired can be read there, such as the name and address of the owner of the card, the name of the company providing service by use of the card, and so forth. A solid line represents the printing applied to the outer faces of the two foils 20, 21 of FIG. 1. The two films 22, 23 are generally required

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for protecting the printing and for the sake of the outer appearance of the card. These films are ordinarily made of a transparent PVC crystal that makes the card glossy and have a thickness on the order of 25 μm . Ordinarily, the two foils are covered with their respective films and then applied and affixed to the small plate by thermocompression. Consequently, the term "foils" extends generally to the foil provided with its film and must thus be included in the general sense of the word, in particular as recited in the claims.

Again in the conventional manner, the printed circuit 14 is inserted between the plate 19 and the foil 20. The face 19a of the plate 19 has a zone 24 that is covered by the face 14a of the printed circuit 14 and a cavity 25 for accommodating the integrated circuit 11. In the example shown, the cavity 25 is a hole penetrating the plate 19. The foil 20 covers the printed circuit 14 and includes openings 26 that correspond with the contacts 12. In the example shown, only two openings 26 are provided, each for giving access to one group of three contacts 12. In the technique of the prior art, the printed circuit 14 rested on the zone 24 that was made uniformly planar. In this manner, the contacts 12 were placed approximately at the level of the face 19a of the plate 19. Under those conditions, the contacts were not accessible except through the entire thickness of the foil 20 and the film 22, which made a total of approximately 155 μm . Since this kind of depth cannot be allowed, the problem was to raise the contacts 12 in the openings 26 to make them closer to the outer surface 22a of the card and, if possible, to put them at this level.

According to the invention, the zone 24 includes a boss 27 under each of the two openings 26. The height of the boss is preferably the thickness of the foil 20 and of the film 22, if present, so as to put the contacts 12 at the level of the face 22a of the card 10.

The boss 27 shown is common to the three contacts 12 included in each opening 26. Naturally, a single boss would suffice, if all the contacts 12 were included in the same opening 26.

It will be understood that this boss 27 may be formed on the plate 19 prior to the mounting of the printed circuit 14. For example, the plate 19 may be molded to obtain a zone 24 provided with two bosses 27. The hole 25 could be made during or after the molding. The printed circuit would then be put in place, and then the foils 20 and 21, provided with their respective films 22, 23, would be put in place and pressed for their fixation onto the plate 19. The pressure would thus be exerted in such a way that the bosses 27 would raise the contacts 12 in the openings 26.

FIGS. 3A-3E illustrate a different method of manufacture of the card 10 shown in FIGS. 1 and 2.

FIGS. 3A-3E respectively illustrate the intermediate phases of the method. In the initial step, in FIG. 3A, only the plate 19 is present, pierced with the hole 25 and provided with two faces 19a, 19b, which are uniformly plane and parallel. In FIG. 3B, the printed circuit 14, provided with the integrated circuit 11 accommodated in the cavity 25, has been placed on the face 19a of the plate 19. In FIG. 3C, a die 28 has been placed over the printed circuit 14, and the unit comprising the plate 19, the printed circuit 14 and the die 28, has been locked in the jaws 29 of a heating press 30. The die 28 is a uniformly plane metal blade pierced with openings 31 that correspond to the openings 26 of the foil 20 shown in FIG. 1. The die 28 shown has a surface area greater than that of the printed circuit 14. The metal comprising

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the die 28 is a good thermal conductor. Consequently, the heat given off by the jaws 29 of the press 30 softens the material comprising the plate 19 at the level of the printed circuit 14, and the force of the pressure exerted by the jaws 29 drives the printed circuit 14 into the plate 19. This operation lasts until the die 28 comes into contact with the face 19a of the plate 19. By way of example, the pressing operation for an ordinary PVC plate is done between 120° C. and 140° C., which is reached in 10 minutes, and is maintained for 10 minutes at a pressure of 60 bars. After the press has been raised, the configuration shown in FIG. 3D is thus obtained. In this figure, it can be seen that the pressing has been done in such a way as to put the upper face 14b of the printed circuit 14 approximately at the level of the face 19a of the plate 19. The pressing has thus created the indented zone 24 in the face 19a of the plate. At the same time, the openings 31 of the die 28 have permitted the formation of the bosses 27. It will be clear to one skilled in the art that the height of the bosses 27 obtained by this method depends on the thickness of the printed circuit, the thickness of the die 28, and the softening temperature of the PVC. In the step shown in FIG. 3E, the die 28 has been withdrawn, and the cavity 25 has been filled with an embedding substance 32. Hence it suffices to emplace and affix the foils 20 and 21, provided with their respective films 22, 23, in order to obtain the card shown in FIGS. 1 and 2.

This method can be embodied in several variant ways. For example, to avoid heating the integrated circuit 11, it would be sufficient, in the step shown in FIG. 3B, to put only the printed circuit 14 in place, without the integrated circuit 11, and to weld the integrated circuit in the step shown in FIG. 3E, prior to the embedding. On the other hand, in FIG. 3A, one could begin with the plate 19 provided with the foil 21 and with its film 23, if present, or in a similar manner one could begin with a one-piece plate with two parallel faces, one of which would be provided solely with the cavity 25. Moreover, the die 28 could be a plane blade that is a good thermal conductor that covers only the printed circuit 14. In that case, a control and stop device would have to be used for controlling the depth to which the printed circuit is driven into the plate 19. The advantage of having a blade extending beyond the printed circuit, as shown, is that it is possible to use the blade as a stop means against the face 19a of the plate.

FIGS. 4 and 5 illustrate two variant embodiments of a card 10 according to the invention which can be made by the method that has just been described and its variants. The elements of FIG. 1 that remain unchanged in the variants of FIGS. 4 and 5 are identified by the same reference numerals. FIGS. 4 and 5 correspond to two variant embodiments of the printed circuit with offset contacts 14. In FIGS. 4 and 5, the printed circuit is designed for connection with wires, presently known as wire bonding.

In FIG. 4, the printed circuit 114 differs from the circuit 14 only at the level of the integrated circuit 11. The lead 18 closes the opening 16 at the level of the face 114a. The integrated circuit 11 has its back face glued to the lead 18, and the pads 11a are connected to the corresponding conductors 15 by wires 33 that penetrate the substrate 17 in holes 34.

In FIG. 5, the printed circuit 11 is no longer connected through a window 16 as in FIGS. 1 and 4, such that the conductors 15 and the contacts 12 are disposed on the face 214a of the printed circuit 214. Conse-

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quently, the contacts cannot be accessible from the face 214b except through a window 35 made in the substrate 17. Each boss 27 must accordingly compensate for the thickness of the substrate 17 and foil 20. Advantageously, the foil 20 and/or the substrate 17 will be thinned down so as not to exert strong stresses on the conductors 15 or in the contacts 14 at the level of the angles formed by each boss 27.

FIG. 6 shows another variant embodiment of a card 10 according to the invention. In this variant, the printed circuit 314 is no longer a printed circuit with offset contacts like those described above. Instead, it is a printed circuit as described in the aforementioned French Patent 2 337 381. In the example shown, the two rows of contacts 12 are placed on two opposite sides of the openings 16 made in the substrate 17 of the printed circuit 314. The conductors 15 are placed overhanging about the opening 16 and are welded to the pads 11a of the integrated circuit 11 by the TAB technique. The card 10 is formed of a one-piece small plate 319, the face 319a of which has the cavity 25, the zone 24 and a step 36, which are coaxial. The printed circuit 314 rests on the zone 24, and the integrated circuit 11 is accommodated in the cavity 25. The foil 20 of FIGS. 1-5 here is limited to a cover cap affixed to the step 36 and coplanar with the face 319a of the plate 319. The cover cap 320 has the two openings 26 for giving access to the two rows of contacts 12. According to the invention, the zone 24 has one boss 27 under each opening 26, in a manner similar to that of the foregoing drawing figures. It will be understood that the step 36 could be omitted, and the foil 20 could extend over the entire surface 319a of the plate 319.

The method for manufacture described with reference to FIGS. 1 and 3A-3E could also apply to the second variant mentioned here. The unit comprising the plate 19 and the foils 20 and 21 of the card shown in FIG. 1 would then, in FIG. 3A, comprise the bare plate 319 of FIG. 6. In the case of the card 10 shown in FIG. 6, formed solely by the one-piece plate 319 provided with the step 36 and the cover cap 20, it is clear that the initial state corresponding to FIG. 3A would be the one-piece plate 319 provided with its cavity 25, surrounded by an indented field or zone 37 having the depth of the step 36 and having the surface area of the step, added to that of the face 314b of the printed circuit 314. The zone 24 and its bosses 27 would be formed when the printed circuit is pressed until the upper face 314b of the printed circuit 314 is approximately coplanar with the step 36. The aforementioned field or zone 37 would naturally have the surface area of the face 319a, if the foil 20 were distributed over this face.

We claim:

1. A method of manufacturing a card (10) comprising a printed circuit (14) having one face (14a) which carries an integrated circuit (11) and another face (14b) having a plurality of contacts (12), a plate (19) having one face (19a) which has a plane zone (24) including a boss covered by the printed circuit and a cavity (25) for accommodating the integrated circuit, a foil (20) disposed to cover at least the printed circuit and arranged to provide access to the contacts via at least one opening (26) in the foil, the zone (24) including the boss (27) being disposed under the opening (26) of the foil (20), wherein the printed circuit (14) is accommodated on one face (19a) of the plate (19), the plate (19) being constructed of plastic material and including the zone (24), the boss (27) and the cavity (25) for accommodat-

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ing the integrated circuit (11), the method comprising the steps of forming the cavity (25) in a uniformly plane zone (37) of the one face of the plate having a predetermined surface area corresponding to that of the foil disposing the printed circuit (14) in the plane zone (37), covering the printed circuit with a predetermined surface area of the foil (20), disposing a plane blade die (28) that is a good thermal conductor and is provided with an opening corresponding to said opening (26) of the foil above the printed circuit (14), heating the plate to a molding temperature, pressing the die to shape the printed circuit such that the upper face (14b) of the printed circuit is approximately coplanar with said plane zone (37) and withdrawing the die.

2. A method as defined by claim 1, characterized in that it further includes forming an indented step (36) in the face (19a) of the plate, the plane zone (37) having the depth of the step (36) and affixing a foil cover cap to said step.

3. A method as defined by claim 2, characterized in that the cavity (25) is a hole penetrating the plate.

4. A method as defined by claim 3, characterized in that it comprises filling the hole with an embedding substance (32).

5. A method as defined by claim 3, characterized in that it comprises covering the other face (19b) of the plate (19) with a second foil (21).

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6. A method as defined by claim 1, characterized in that the printed circuit (14) is equipped with the integrated circuit (11).

7. A method as defined by claim 1, characterized in that the printed circuit (14) is equipped with the integrated circuit (11).

8. A method as defined by claim 1, characterized in that the cavity (25) is a hole penetrating the plate.

9. A method as defined by claim 8, characterized in that with the printed circuit (14) not yet equipped with the integrated circuit (11), the method comprises, after the formation of the boss, connecting the integrated circuit (11) to the printed circuit (14) in the hole (25) of the plate (19).

10. A method as defined by claim 9, characterized in that it comprises filling the hole with an embedding substance (32).

11. A method as defined by claim 9, characterized in that it comprises covering the other face (19b) of the plate (19) with a second foil (21).

12. A method as defined by claim 8, characterized in that it comprises filling the hole with an embedding substance (32).

13. A method as defined by claim 8, characterized in that it comprises covering the other face (19b) of the plate (19) with a second foil (21).

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